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FOR NEET 2025

Lecture- 01 | Inorganic Chemistry

Classification of Elements and Periodicity in Properties

By - Mohit Dadheech (MD Sir)

Topics *to be covered*

1. Basics of Present format periodic table
2. Layout & mnemonics of periodic table.

Ha to Raja Aao shuru Karte Hai.....

#feel wali IOC

Recap :-

Quantum Numbers

(PQN) Principal Q.N $\Rightarrow$ n $\Rightarrow$ shell no. 1, 2, 3, 4 . . . .

AQN $\rightarrow$ ℓ $\Rightarrow$ subshell s, p, d, f . . .
(0, 1, 2, 3)

$[\ell = 0 \text{ to } n-1]$

3s

shell no. (n)

$n = 3$
$\ell = 0$

$(n+\ell)$ Rule

$n = 3$

$l = ?$

shell

$l = 0$ to $n-1$

0, 1, 2

s p d

3s, 3p, 3d ✓

Subshells

$n = 4$

$l = 0, 1, 2, 3$

s p d f

(n) 3rd shell → subshells ?

(n) 3rd period → subshells 6

Basics of long form of Periodic Table :

Modern Periodic Law :

"The physical & chemical properties of elements are periodic functions of their atomic number (Z)"

(Z) = 1 2 3 4

H He Li Be

$1e^-$ $2e^-$ $3e^-$ $4e^-$

1pt 2pt 3pt 4pt

(Z) = no. of Protons

Na $Z = 11$ $p^+ = 11$ $e^- = 11$

Na^+ $p^+ = 11$ $e^- = 10$

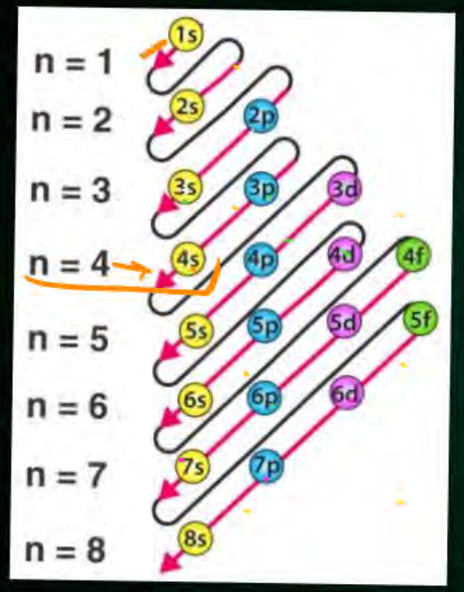
* In Periodic Table elements are arranged in order of Increasing atomic number

Thus each element Contains one more electron & proton than preceding element

Z →	1	2	3	4	5	. . . . .
	H	He	Li	Be	B	. . .
e^-	1	2	3	4	5	. . .
p^+	1	2	3	4	5	. . .

* 7 Horizontal lines → Periods (n)
(L → R)
denoted by "n"

* 18 Vertical Columns → Groups
(1 to 18)



For filling sequence.

(n+l) Rule

s p d f

7p ← 6d ← 5f ← 7s

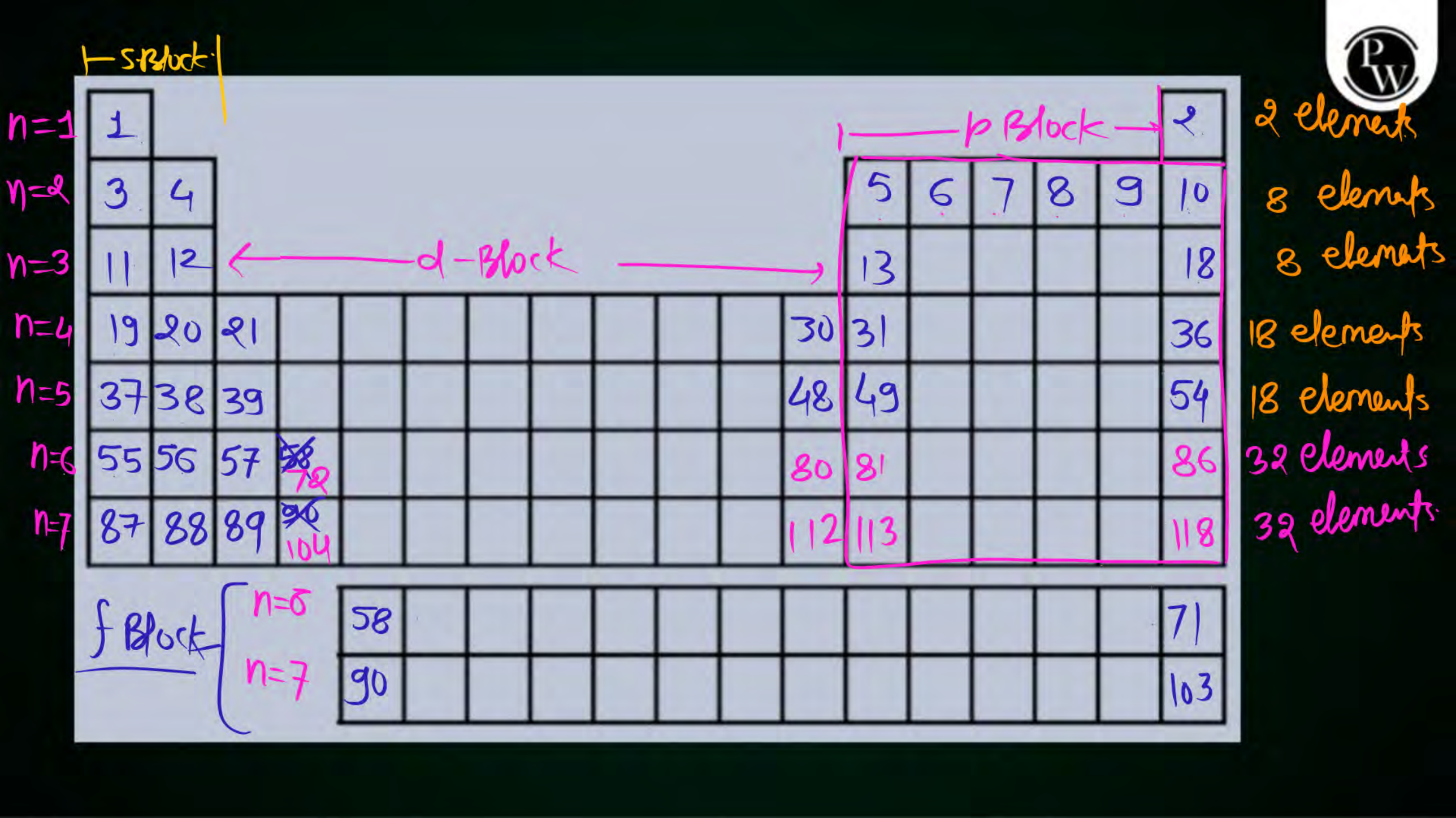
6e⁻ + 10e⁻ + 14e⁻ + 2e⁻

n=7

32e⁻

1s → 2s → 2p → 3s → 3p → 4s → 3d → 4p → 5s → 4d → 5p → 6s → 4f → 5d → 6p

n=1	n=2	n=3	n=4	n=5	n=6
2e⁻	2e⁻ + 6e⁻	2e⁻ + 6e⁻	2e⁻ + 10e⁻ + 6e⁻	2e⁻ + 10e⁻ + 6e⁻	2e⁻ + 14e⁻ + 10e⁻ + 6e⁻
	8e⁻	8e	18e⁻	18e⁻	32e⁻


s-Block
p Block
d-Block
f Block
n=1
n=2
n=3
n=4
n=5
n=6
n=7
1
2
3
4
11
12
5
6
7
8
9
10
13
18
19
20
21
30
31
36
37
38
39
48
49
54
55
56
57
72
80
81
86
87
88
89
104
112
113
118
58
71
90
103
n=6
n=7
2 elements
8 elements
8 elements
18 elements
18 elements
32 elements
32 elements

Formula of Periodic Table :

(n+l) Rule

$ns \to (n-2)f \to (n-1)d \to np$

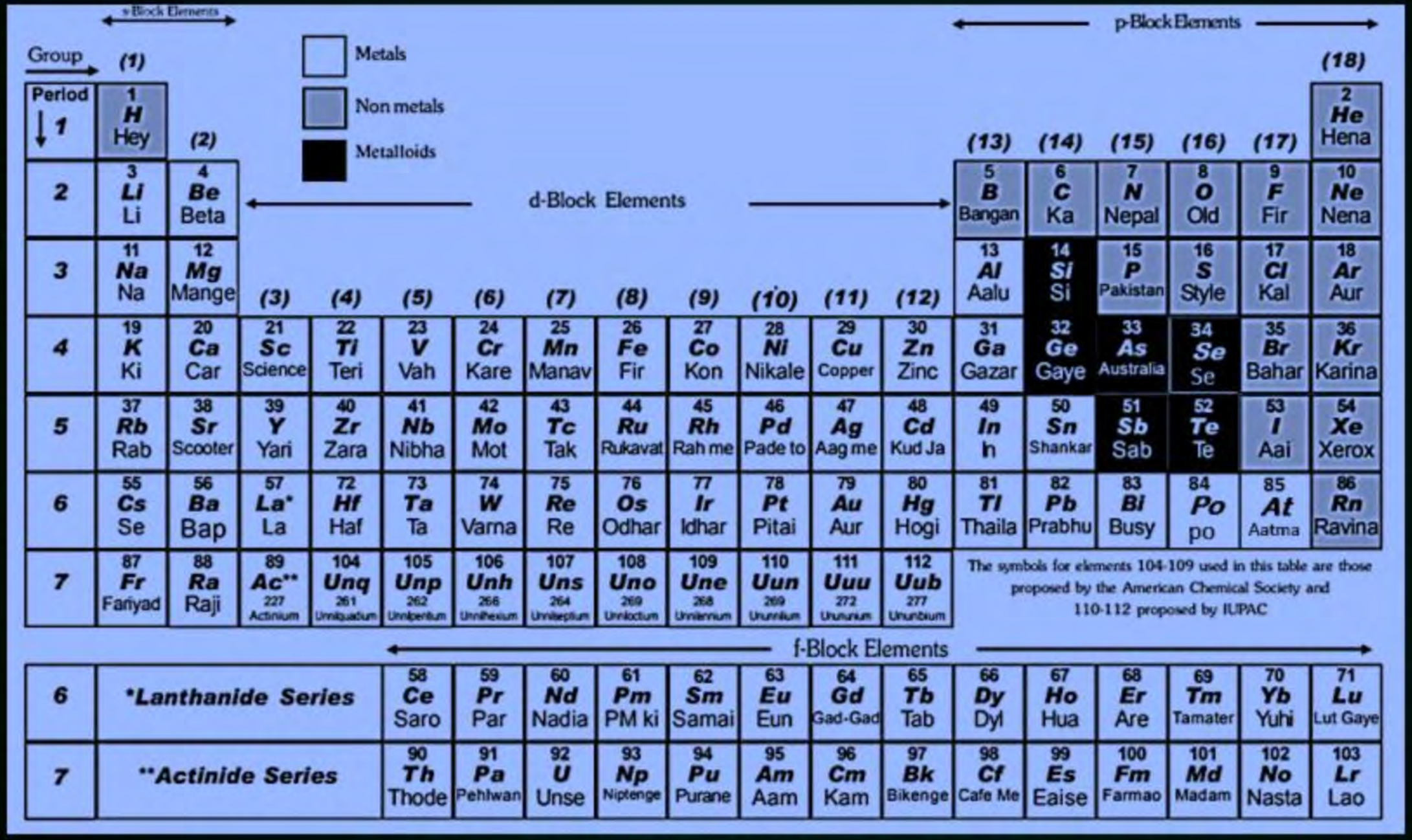
Formula

(n)	Period subshells	no. of elements
n=1	1s	2
n=2	2s ⟶ 2p	8
n=3	3s ⟶ 3p	8
n=4	4s → 3d → 4p	18
n=5	5s → 4d → 5p	18
n=6	6s → 4f → 5d → 6p	32
n=7	7s → 5f → 6d → 7p	32

6s → 4f → 5d → 6p
ns (n-2)f (n-1)d np

MDJ

s
sp
spd
spdf
spdf
spdf


s-Block Elements
p-Block Elements
Group
(1)
(18)
Metals
Non metals
Metalloids
Period
1 H Hey
2 He Hena
(2)
(13) (14) (15) (16) (17)
2 Li Li; Be Beta; B Bangan; C Ka; N Nepal; O Old; F Fir; Ne Nena
3 Na Na; Mg Mange; Al Aalu; Si Si; P Pakistan; S Style; Cl Kal; Ar Aur
d-Block Elements
(3) (4) (5) (6) (7) (8) (9) (10) (11) (12)
4 K Ki; Ca Car; Sc Science; Ti Teri; V Vah; Cr Kare; Mn Manav; Fe Fir; Co Kon; Ni Nikale; Cu Copper; Zn Zinc; Ga Gazar; Ge Gaye; As Australia; Se Se; Br Bahar; Kr Karina
5 Rb Rab; Sr Scooter; Y Yari; Zr Zara; Nb Nibha; Mo Mot; Tc Tak; Ru Rukavat; Rh Rah me; Pd Pade to; Ag Aag me; Cd Kud Ja; In In; Sn Shankar; Sb Sab; Te Te; I Aai; Xe Xerox
6 Cs Se; Ba Bap; La* La; Hf Haf; Ta Ta; W Varna; Re Re; Os Odhar; Ir Idhar; Pt Pitai; Au Aur; Hg Hogi; Tl Thaila; Pb Prabhu; Bi Busy; Po po; At Aatma; Rn Ravina
7 Fr Fariyad; Ra Raji; Ac** 227 Actinium; 104 Unq 261 Unnilquadium; 105 Unp 262 Unnilpentium; 106 Unh 266 Unnilhexium; 107 Uns 264 Unnilseptium; 108 Uno 269 Unniloctium; 109 Une 268 Unnilennium; 110 Uun 269 Ununnilium; 111 Uuu 272 Unununium; 112 Uub 277 Ununbium
The symbols for elements 104-109 used in this table are those proposed by the American Chemical Society and 110-112 proposed by IUPAC
f-Block Elements
6 *Lanthanide Series: 58 Ce Saro; 59 Pr Par; 60 Nd Nadia; 61 Pm PM ki; 62 Sm Samai; 63 Eu Eun; 64 Gd Gad-Gad; 65 Tb Tab; 66 Dy Dyl; 67 Ho Hua; 68 Er Are; 69 Tm Tamater; 70 Yb Yuhi; 71 Lu Lut Gaye
7 **Actinide Series: 90 Th Thode; 91 Pa Pehlwan; 92 U Unse; 93 Np Niptenge; 94 Pu Purane; 95 Am Aam; 96 Cm Kam; 97 Bk Bikenge; 98 Cf Cafe Me; 99 Es Eaise; 100 Fm Farmao; 101 Md Madam; 102 No Nasta; 103 Lr Lao

Trick

S & P

T → B

d & f → L → R

QUESTION

After the filling of np-orbitals next orbital filled will be:

n=5

5s → 4d → 5p

ns → (n-2)f → (n-1)d → (np)

6s → 4f → 5d → 6p

(n+1)s (n-1)f nd (n+1)p

w.r.t n=5

A ns ✗

B (n + 1)p ✓

C (n – 1)d ✗

D (n + 1)d ✗

QUESTION

In the fourth period of the periodic table, how many elements have one or more 4d electrons?

4s → 3d → 4p

4d

A 2

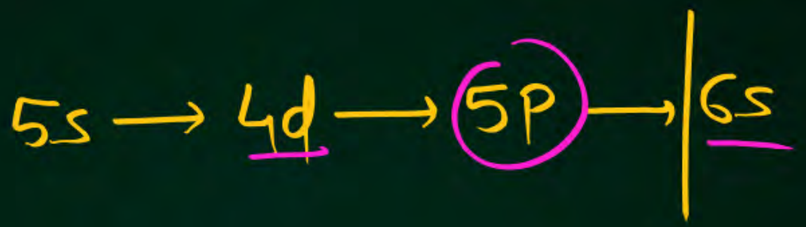
B 18

C 0

D 6

QUESTION

The subshell which are filled just before and just after the filling of 5p subshell are respectively:



A 5s, 5d

B 4d, 6s

C 4d, 4f

D 6s, 4f

QUESTION

If the principal quantum number n = 6, the correct sequence of filling of electrons will be:

A $ns \rightarrow (n-1)d \rightarrow (n-2)f \rightarrow np$

B $ns \rightarrow np \rightarrow (n-1)d \rightarrow (n-2)f$

C $ns \rightarrow (n-2)f \rightarrow (n-1)d \rightarrow np$

D $ns \rightarrow (n-2)f \rightarrow np \rightarrow (n-1)d$

QUESTION

The period number in the long form of the periodic table is equal to

A Magnetic quantum number of any element of the period.

B Atomic number of any element of the period.

C Maximum Principal quantum number of any element of the period.

D Maximum Azimuthal quantum number of any element of the period.

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Lecture- 02 | Inorganic Chemistry

Classification of Elements and Periodicity in Properties

By - Mohit Dadheech (MD Sir)

Topics *to be covered*

1. Basics of Present format periodic table
2. Electronic Configurations

Basics of Present format periodic table

- Groups
- Periods
- Blocks
- Formula of periodic table ✓
- Layout and mnemonics ✓

GROUPS

- 18 vertical Columns (1 to 18)
- Largest group of PT → 3rd → 32 Elements < 28 f Block, 4 d Block
- All f-Block Elements are placed in Same group (3rd group)
- gen Outermost ē configuration remains Same in elements belong to Same group

group No.	Block
1 - 2	s
3 - 12	d
13 - 18	p

group 1 Alkali metals Li, Na, K, Rb, Cs, NaOH, Na_2O } Basic

group 2 Alkaline earth metals Be, Mg - - -

group 3 to 12 d-Block, | 3rd group → 28 f-Block + 4 d Block

group 13 Boron family

14 Carbon Family

15 pnictogens

16 Chalcogens

17 Halogens

18 Inert gases

(n)	(Z)	Name
1	2	He
2	10	Ne
3	18	Ar
4	36	Kr
5	54	Xe
6	86	Rn
7	118	Og

PERIODS

↳ 7 Horizontal lines denoted by "n" (P.Q.N)

↳ Based on no. of elements present divided into.

shortest	short	long	longest
n=1	n=2,3	n=4,5	n=6,7
(2)	(8)	(18)	(32)

↳ Each Period starts with S-Block & End With p-Block element.
(Alkali Metal) (Noble gas)

↳ Lanthanoids & Actinoids are placed into 6th & 7th Periods Respectively

↳ No. of Elements in a given period "n"

(i) If "n" is odd no. $= \frac{(n+1)^2}{2}$ Ex $n=5$, $\frac{(5+1)^2}{2} = 18$

(ii) If "n" is even no. $= \frac{(n+2)^2}{2}$ Ex $n=6$, $\frac{(6+2)^2}{2} = 32$

↳

NCERT LIVE ***

Number of elements in each period is twice the number of atomic orbitals available in energy level that is being filled

Ex $n=2$ 2s 2p $4 \times 2 = 8$

BLOCKS

↳ Four Blocks s, p, d, f are present in PT

↳ Name of Blocks are given on the basis of Subshell in which Last e^- enters.

s-Block → Last e^- enters into "s" subshell

p-Block → Last e^- enters into p subshell (Except He $1s^2$)

d-Block → Last e^- enters into "d"

f-Block → —n—— into "f"

How to write Electronic Configuration of any Element except exceptions :

$n+l$

$ns \rightarrow (n-2)f \rightarrow (n-1)d \rightarrow np$

s
s p
s p
s d p
s d p
s f d p
s f d p

step-I

find period no. (n) of given (Z)

Z = 32

next inert gas = 36

n = 4

n of given Z = n of next inert gas

32 − 18 = 14

[Ar] $4s^2 \rightarrow 3d^{10} \rightarrow 4p^2$

Z = 18

step-2

[Pre. Inert gas] $ns \rightarrow (n-2)f \rightarrow (n-1)d \rightarrow np$

↓ according to Period no.

$Z = 80$

$n = ?$

$n = 6$

Next inert gas → 86

$n = 6$

Pre inert gas ⇒ (Xe) $Z = 54$

$$80 - 54 = 26\ e^-$$

$$[Xe]\ 6s^2 \rightarrow 4f^{14} \rightarrow 5d^{10} \rightarrow 6p^0$$

(or)

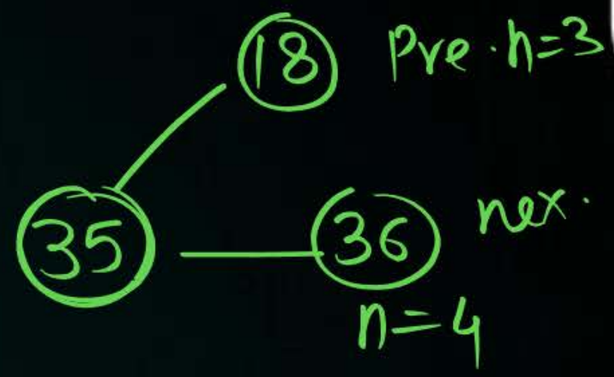
$$[Xe]\ 4f^{14}\ 5d^{10}\ 6s^2$$

$Z = 35$ $n = 4$

$35 - 18 = 17$

$(18)[Ar]\ 4s^2 \rightarrow 3d^{10} \rightarrow 4p^5$

$[Ar]\ 3d^{10}\ 4s^2\ 4p^5$



$Z = 51$

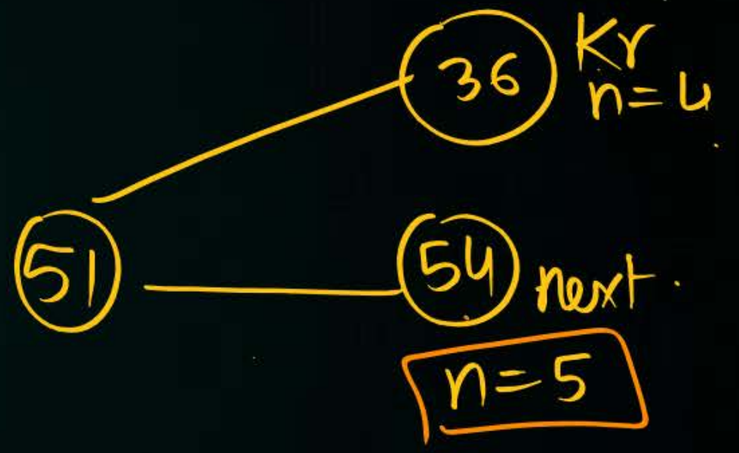
$n = 5$

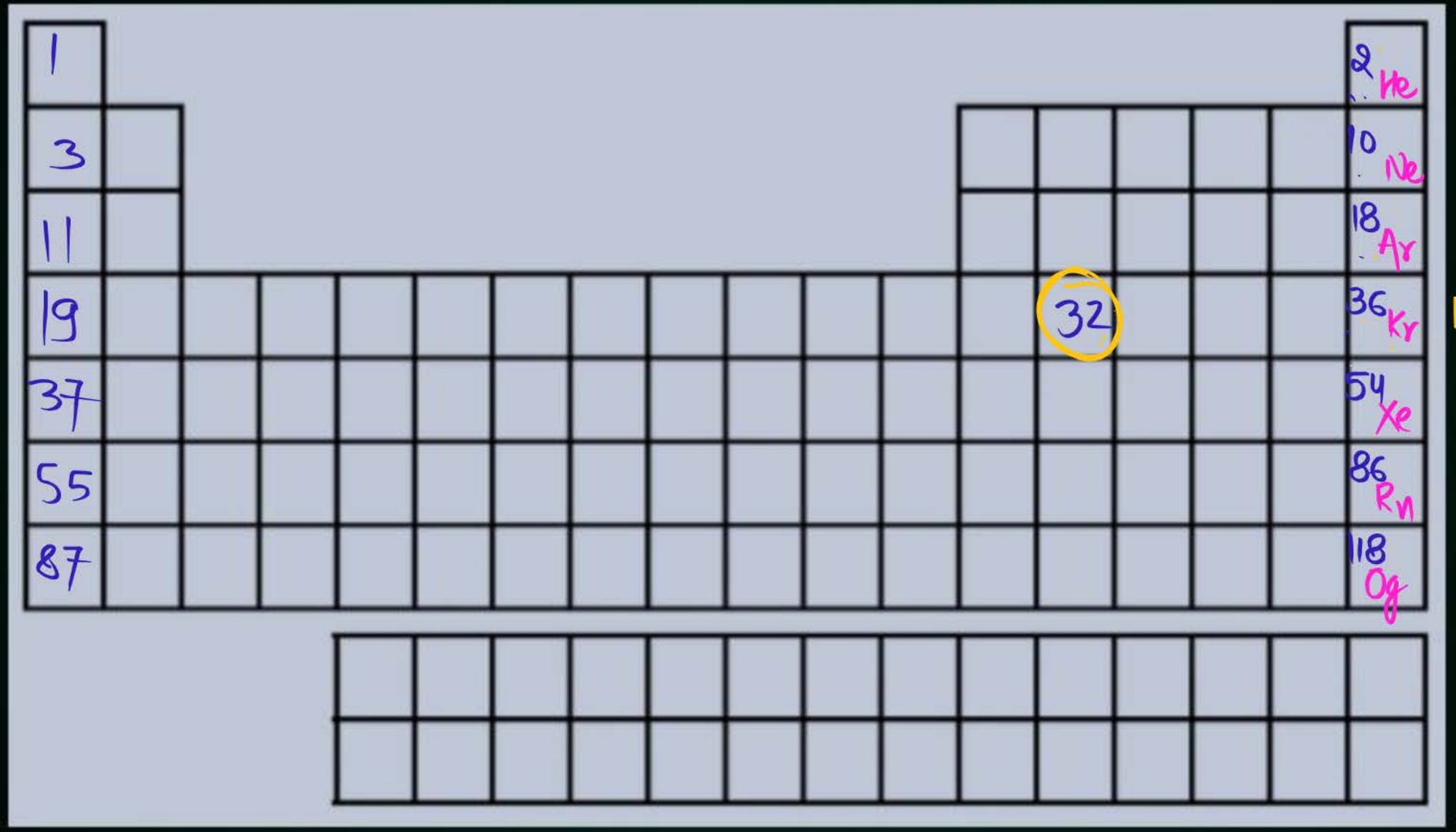
$51 - 36 = 15$

$(36)[Kr]\ 5s^2 \rightarrow 4d^{10} \rightarrow 5p^3$

or

$[Kr]\ 4d^{10}\ 5s^2\ 5p^3$




1
3
11
19
37
55
87
2 He
10 Ne
18 Ar
36 Kr
54 Xe
86 Rn
118 Og
32
n=4

Nomenclature of elements with Atomic Number Above 100 :

Digit	Name
0	Nil
1	Un
2	Bi
3	Tri
4	Quad
5	Pent
6	Hex
7	Sept
8	Oct
9	Enn

Suffix → ium

Ex z = 111

Un Un Un + ium

UnUnUnium (Uuu)

z = 105

Un nil Pent + ium.

Unnilpentium (Unp)

Atomic Number	Name according to IUPAC nomenclature	Symbol	IUPAC Official Name	IUPAC Symbol	TRICK
101	Unnilunium	Unu	Mendelevium	Md	Modi ka
102	Unnilbium	Unb	Nobelium	No	Number
103	Unniltrium	Unt	Lawrencium	Lr	Lahore ke
104	Unnilquadium	Unq	Rutherfordium	Rf	Refugee ne
105	Unnilpentium	Unp	Dubnium	Db	Dubai aur
106	Unnilhexium	Unh	Seaborgium	Sg	Singapore ke
107	Unnilseptium	Uns	Bohrium	Bh	Bahar diya
108	Unniloctium	Uno	Hassium	Hs	Hans
109	Unnilennium	Une	Meitnerium	Mt	Mat
110	Ununnilium	Uun	Darmstadtium	Ds	Dus
111	Unununnium	Uuu	Rontgenium	Rg	Rang ka
112	Ununbium	Uub	Copernicium	Cn	Konsa
113	Ununtrium	Uut	Nihonium	Nh	Nahi
114	Ununquadium	Uuq	Flerovium	Fl	Flower
115	Ununpentium	Uup	Moscovium	Mc	Mac
116	Ununhexium	Uuh	Livermorium	Lv	Lovers
117	Ununseptium	Uus	Tennessine	Ts	Tussi
118	Ununoctium	Uuo	Oganesson	Og	O god

Blockwise e^- Configurations

S-Block

gen outer e^- Configuration $\Rightarrow$ ns^{1-2}

group No. of S-Block = no. of ns e^-

n=	group-1	group-2
2	Li [He] $2s^1$	Be [He] $2s^2$
3	Na [Ne] $3s^1$	Mg [Ne] $3s^2$
4	K [Ar] $4s^1$	Ca [Ar] $4s^2$
5	Rb [Kr] $5s^1$	Sr [Kr] $5s^2$
6	Cs [Xe] $6s^1$	Ba [Xe] $6s^2$
7	Fr [Rn] $7s^1$	Ra [Rn] $7s^2$

ns^1 → Alkali Metals

ns^2 → Alkaline earth Metals

p-Block

gen outer e^- Configuration → $ns^2\ np^{1-6}$

Group	13 (ns^2np^1)	14 (ns^2np^2)	15 (ns^2np^3)	16 ns^2np^4	17 ns^2np^5	18 ns^2np^6
n=2	B [He] $2s^2\ 2p^1$					
3	Al [Ne] $3s^2\ 3p^1$					
4	Ga [Ar] $4s^2\ 3d^{10}\ 4p^1$					
5	In [Kr] $5s^2\ 4d^{10}\ 5p^1$					
6	Tl [Xe] $6s^2\ 4f^{14}\ 5d^{10}\ 6p^1$					

H.W

NCERT KI CHOTI CHOTI MAGAR MOTI BAATEIN

- Atomic number is equal to the nuclear charge (i.e., number of protons) or the number of electrons in a neutral atom. It is then easy to visualize the significance of quantum numbers and electronic configurations in periodicity of elements. In fact, it is now recognized that the Periodic Law is essentially the consequence of the periodic variation in electronic configurations, which indeed determine the chemistry physical and chemical properties of elements and their compounds.

- Numerous forms of Periodic Table have been devised from time to time. Some forms emphasise chemical reactions and valence, whereas others stress the electronic configuration of elements. A modern version, the so-called "long form" of the Periodic table of the elements, is the most convenient and widely used. The horizontal rows (which Mendeleev called series) are called periods and the vertical columns, groups. Elements having similar outer electronic configurations in their atoms are arranged in vertical columns, referred to as groups or families. According to the recommendation of International Union of Pure and Applied Chemistry (IUPAC), the groups are numbered from 1 to 18 replacing the older notation of groups IA ... VIIA, VIII, IB ... VIIB and 0. There are altogether seven periods.

- The period number corresponds to the highest principal quantum number (n) of the elements in the period. The first period contains 2 elements. The subsequent periods consists of 8, 8, 18, 18 and 32 elements, respectively. The seventh period is incomplete and like the sixth period would have a theoretical maximum (on the basis of quantum numbers) of 32 elements. In this form of the Periodic Table, 14 elements of both sixth and seventh periods (lanthanoids and actinoids, respectively) are placed in separate panels at the bottom.

QUESTION

Which statements is wrong for the long form of periodic table ?

A 18 Elements are present in 5th period ✓

B No. of valence shell electrons in a period are same (Outer) ✗

C 3rd group contains 32 elements ✓

D Lantanides and actinides are placed in same group ✓

QUESTION

Lanthanoids are :- [AIPMT 2004]

A 14 elements in the seventh period (Atomic no.= 58 to 71) that are filling 4f sub level

B 14 elements in the sixth period (atomic no.= 90 to 103) that are filling 4f sublevel

C 14 elements in the seventh period (atomic no.= 90 to 103) that are filling 5f sublevel

D 14 elements in the sixth period (atomic no=58 to 71) that are filling 4 f sublevel

QUESTION

Which of the following is not an actinoid ?

H.W

A Curium (Z = 96)

B Californium (Z = 98)

C Uranium (Z = 92)

D Terbium (Z = 65)

QUESTION

The elements in which electrons are progressively filled in 4f-orbital are called

f Block

A actinoids

B transition elements

C lanthanoids

D halogens

H.W

QUESTION

The element with atomic numbers 35, 53, and 85 are all _____ .

A noble gases

B halogens

C heavy metals

D light metals

17 Halogens

18 Inert

9

17

35

10

18

36

QUESTION

Largest group of periodic table is :

H.W

A 18

B 16

C 2

D 3

QUESTION

Last element of 5th period is :

A Br

B Rn

C Xe

D Og

QUESTION

Total number of d block elements present in 3 period are :

A 10

B 0

C 18

D 32

H.W

QUESTION

Total number of elements present in f block are :

H.W

A 14

B 28

C 32

D 18

QUESTION

Which of the following atomic number belongs to s block :

A 35

B 68

C 55

D 21

QUESTION

$p^6 \longrightarrow 6p^6$

The last element of the p-block in 6th period is represented by the outermost electronic configuration.

A $7s^2\ 7p^6$

B $5f^{14}\ 6d^{10}\ 7s^2\ 7p^0$

C $4f^{14}\ 5d^{10}\ 6s^2\ 6p^6$

D $4f^{14}\ 5d^{10}\ 6s^2\ 6p^4$

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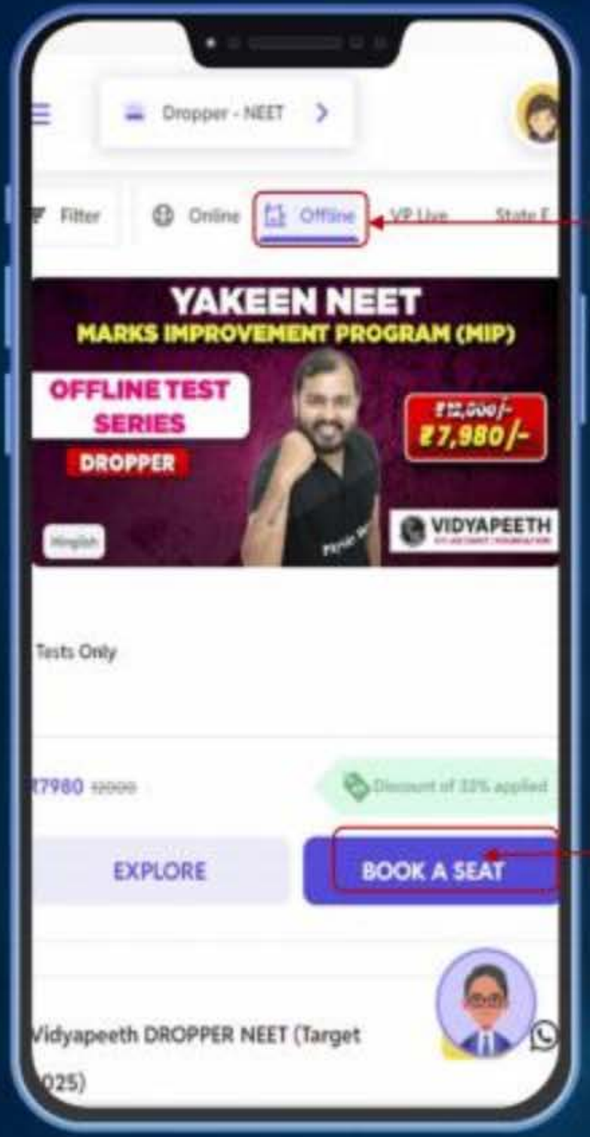

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Lecture-03 | Inorganic Chemistry

Classification of Elements and Periodicity in Properties

By - Mohit Dadheech (MD Sir)

Topics *to be covered*

1. Electronic configurations of d & f Blocks.
2. Group, Block, Period identification

(Except 1st Period)

Each Period in P.T starts with a Subshell of new shell (s) and ends with :-

(1) next shell

(2) Same Subshell

(3) p Subshell of ~~next~~ shell

(4) p Subshell of Same Shell.

$ns \rightarrow (n-2)f \rightarrow (n-1)d \rightarrow np$

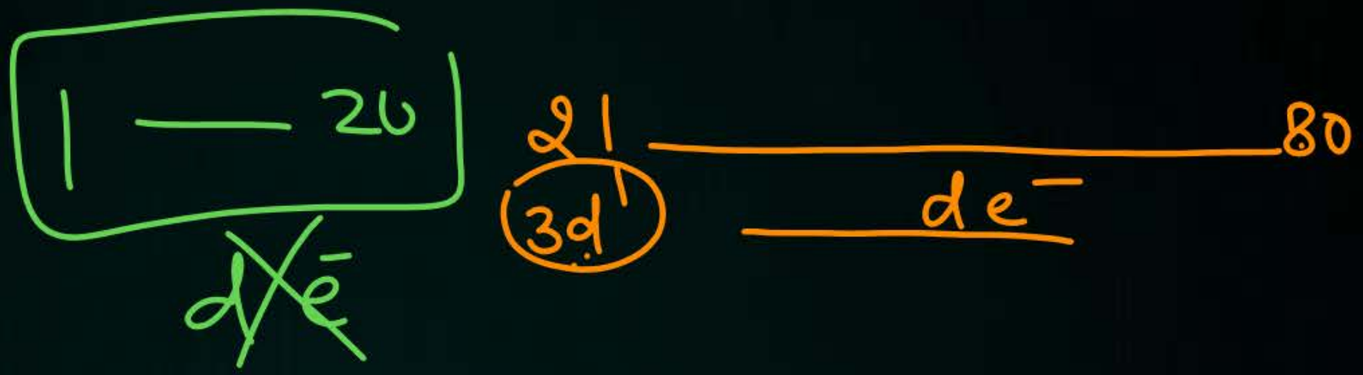
Q out of First 80 elements how many have $d\ \bar{e}$

(1) 80

(2) 20

(3) 60

(4) 40



$80 - 20 = 60$

Q Total no. of "s" e^- in Unipositive ion of element having Z=55

Cs $[Xe]\ 6s^1$

Unipositive Cs^+ $[Xe]\ 6s^0$

$1s\ 2s\ 3s\ 4s\ 5s$

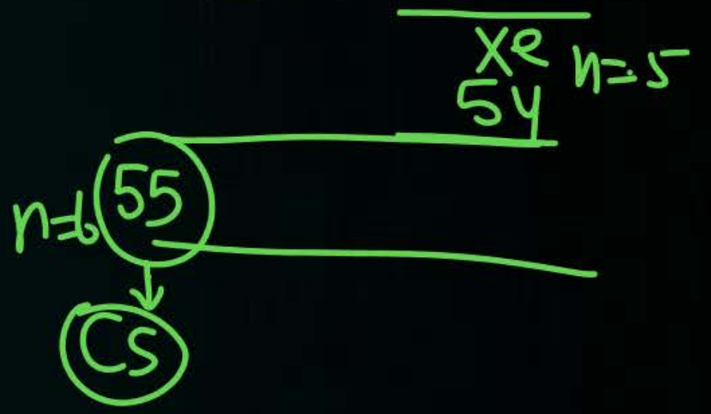
Total "s" e^- $2+2+2+2+2 = 10e^-$

Total "p" e^- ~~1p~~ $2p\ 3p\ 4p\ 5p$ $6+6+6+6 = 24$

Total "d" e^- ~~2d~~ ~~3d~~ $3d\ 4d$ $10+10 = 20\ e^-$

Z=55 → Period

n=6



Q An Element which belongs to 3rd period & 15th group is :–

(1) $1s^2 2s^2 2p^6 3s^2$ ✗

(2) $1s^2 2s^2 2p^6 3s^2 3p^3$ ✓

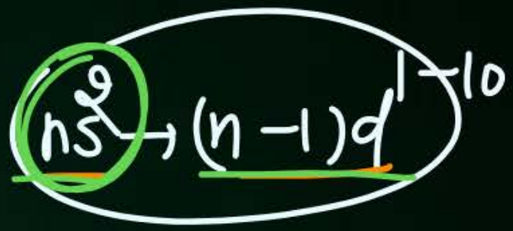
(3) $1s^2 2s^2 2p^3$ ✗

(4) $[Ne]\ 3s^2 3p^5$ ✗

15th group → $ns^2 np^3$ → $3s^2 3p^3$

Block wise General Electronic Configuration :

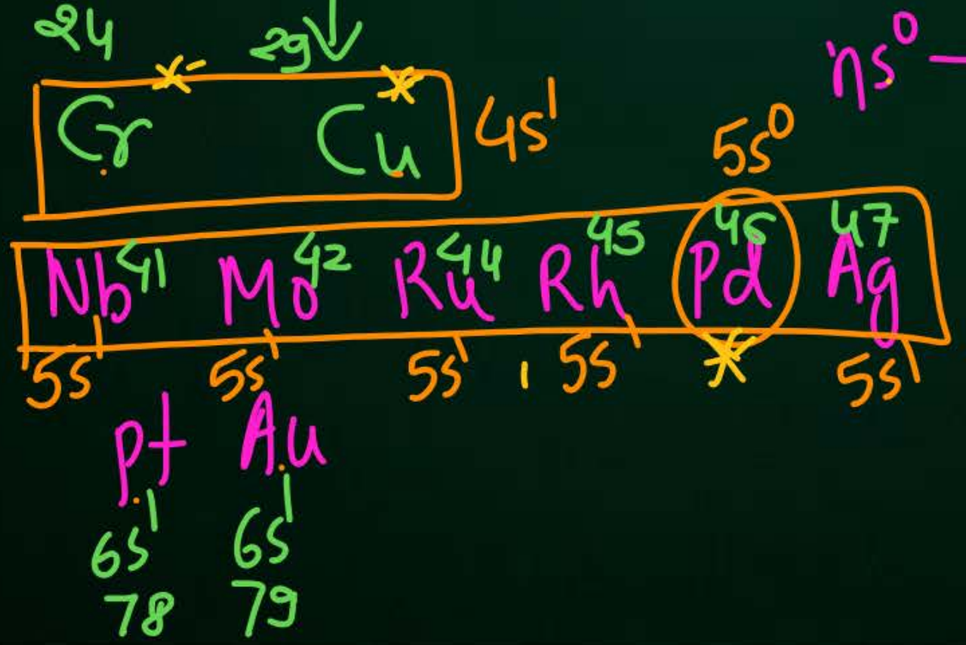
d-block → $ns^{0/1/2}(n-1)d^{1-10}$ or $(n-1)d^{1-10}\ ns^{0/1/2}$



ns^2 → Normal

ns^1 → Exceptional

ns^0 → Exceptional (Only For One Element ⇒ Pd, Z = 46)



$ns \rightarrow (n-1)d$

d - Block

- 3d series: Sc (21) ⟶ Zn (30) (n = 4)
- 4d series: Y (39) ⟶ Cd (48) (n = 5)
- 5d series: La, Hf (57, 72) ⟶ Hg (80) (n = 6)

3d Series :- (n=4) Pre·Inertgas = [Ar]

4s → 3d

Sc [Ar] $4s^2 3d^1$

Ti [Ar] $4s^2 3d^2$

V [Ar] $4s^2 3d^3$

Cr [Ar] ~~$4s^2 3d^4$~~ $4s^1 3d^5$

Mn [Ar] $4s^2 3d^5$

Fe [Ar] $4s^2 3d^6$

Co [Ar] $4s^2 3d^7$

Ni [Ar] $4s^2 3d^8$

Cu [Ar] ~~$4s^2 3d^9$~~ $4s^1 3d^{10}$

Zn [Ar] $4s^2 3d^{10}$

MDJ

$3d^4$ $3d^9$ XX

$3d^5$ $3d^{10}$ Repeats.

4d Series (n=5) Pre Inertgas [Kr] [Kr] $5s \rightarrow 4d$

Y [Kr] $5s^2 4d^1$

Zr [Kr] $5s^2 4d^2$

* Nb [Kr] ~~$5s^2 4d^3$~~ $5s^1 4d^4$

* Mo [Kr] ~~$5s^2 4d^4$~~ $5s^1 4d^5$

Tc [Kr] $5s^2 4d^5$

* Ru [Kr] ~~$5s^2 4d^6$~~ $5s^1 4d^7$

* Rh [Kr] ~~$5s^2 4d^7$~~ $5s^1 4d^8$

* Pd [Kr] ~~$5s^2 4d^8$~~ ~~$5s^1 4d^9$~~ $5s^0 4d^{10}$

* Ag [Kr] ~~$5s^2 4d^9$~~ $5s^1 4d^{10}$

Cd [Kr] $5s^2 4d^{10}$

MDT

$4d^3$, $4d^6$, $4d^9$ XX

$4d^5$, $4d^{10}$ Repeats.

5d series :-

$n = 6$ Pre Inert gas [Xe]

[Xe] 6s → 4f → 5d

MDT

$5d^8$ XX

$5d^{10}$ Repeats.

57 La [Xe] $6s^2\ 4f^0\ 5d^1$

72 Hf [Xe] $6s^2\ 4f^{14}\ 5d^2$

Ta [Xe] $6s^2\ 4f^{14}\ 5d^3$

W [Xe] $6s^2\ 4f^{14}\ 5d^4$

Re [Xe] $6s^2\ 4f^{14}\ 5d^5$

Os [Xe] $6s^2\ 4f^{14}\ 5d^6$

Ir [Xe] $6s^2\ 4f^{14}\ 5d^7$

Pt [Xe] ~~$6s^2\ 4f^{14}\ 5d^8$~~ $6s^1\ 4f^{14}\ 5d^9$

Au [Xe] ~~$6s^2\ 4f^{14}\ 5d^9$~~ $6s^1\ 4f^{14}\ 5d^{10}$

Hg [Xe] $6s^2\ 4f^{14}\ 5d^{10}$

Block wise General Electronic Configuration :

f-block $\rightarrow ns^2 (n-2)f^{1-14} (n-1)d^{0/1}$

$ns \rightarrow (n-2)f \rightarrow (n-1)d^0 \rightarrow np$

1-14

$(n-1)d^0$ Normal.

$(n-1)d^1$ Exceptional.

$(n-1)d^2 \rightarrow$ Exceptional only For Th $Z=90$

Lanthanoids 4f series

58	64	71
Ce	Gd	Lu.
$5d^1$	$5d^1$	$5d^1$

Actinoids

91	92	93	96	103
Pa	U	Np	Cm	Lr
$6d^1$	$6d^1$	$6d^1$	$6d^1$	$6d^1$

Lanthanoids (4f series)

58 Ce [Xe] $6s^2$ $4f^1$ $5d^1$
59 Pr [Xe] $6s^2$ $4f^3$ $5d^0$
60 Nd [Xe] $6s^2$ $4f^4$ $5d^0$
61 Pm [Xe] $6s^2$ $4f^5$ $5d^0$
62 Sm [Xe] $6s^2$ $4f^6$ $5d^0$
63 Eu [Xe] $6s^2$ $4f^7$ $5d^0$
64 Gd [Xe] $6s^2$ $4f^7$ $5d^1$
65 Tb [Xe] $6s^2$ $4f^9$ $5d^0$
66 Dy [Xe] $6s^2$ $4f^{10}$ $5d^0$
67 Ho [Xe] $6s^2$ $4f^{11}$ $5d^0$
68 Er [Xe] $6s^2$ $4f^{12}$ $5d^0$
69 Tm [Xe] $6s^2$ $4f^{13}$ $5d^0$
70 Yb [Xe] $6s^2$ $4f^{14}$ $5d^0$
71 Lu [Xe] $6s^2$ $4f^{14}$ $5d^1$

or [Xe] 4f 5d 6s

MDJ = 1 → $4f^0$, $4f^2$, $4f^8$ ✗✗ $4f^7$, $4f^{14}$ Repeats

or

MDJ-2

↳ Abtak 56 Bharo.

[Xe] + $6s^2$

54 + 2 = 56 e^-

Remaining $\bar{e}$ in 4f

* Ce Gd Lu ⇒ $5d^1$

Actinoids - 5f series

90	Th	$[Rn]\ 7s^2\ 5f^0\ 6d^2$
91	Pa	$[Rn]\ 7s^2\ 5f^2\ 6d^1$
92	U	$[Rn]\ 7s^2\ 5f^3\ 6d^1$
93	Np	$[Rn]\ 7s^2\ 5f^4\ 6d^1$
94	Pu	$[Rn]\ 7s^2\ 5f^6\ 6d^0$
95	Am	$[Rn]\ 7s^2\ 5f^7\ 6d^0$
96	Cm	$[Rn]\ 7s^2\ 5f^7\ 6d^1$
97	Bk	$[Rn]\ 7s^2\ 5f^9\ 6d^0$
98	Cf	$[Rn]\ 7s^2\ 5f^{10}\ 6d^0$
99	Es	$[Rn]\ 7s^2\ 5f^{11}\ 6d^0$
100	Fm	$[Rn]\ 7s^2\ 5f^{12}\ 6d^0$
101	Md	$[Rn]\ 7s^2\ 5f^{13}\ 6d^0$
102	No	$[Rn]\ 7s^2\ 5f^{14}\ 6d^0$
103	Lr	$[Rn]\ 7s^2\ 5f^{14}\ 6d^1$

or $[Rn]\ \underline{5f\ 6d\ 7s}$

(MDJ) - 1

$5f^1$ $5f^5$ $5f^8$ ✗✗
$5f^7$ $5f^{14}$ Repeats

(MDJ) - 2

$[Rn] + 7s^2 = 88e^-$

- Ab tak 88 Bharo.
- Remaining e^- 5f Mai

→ Th → $6d^2$

→ 91 92 93 96 103

$6d^1$

Period, Block & Group Identifications :-

Case-I When atomic no (Z) is given

(1) Period no (n) of given Z = n of next inert gas

(2) group No.

$$Z_{given} + 18 - Z_{next\ inert\ gas}$$

* If value comes in -ve then use 32 in Formula.

$$Z_{given} + 32 - Z_{next\ inert\ gas}$$

* do not use this formula For atomic No. Z = 1 to 12

③ Block on the basis of group No.

gp No.	Block
1 – 2	s
3 – 12	d
13 – 18	p

(Note) all f Block element have 3rd group

④ if $58 \leq Z_{given} \leq 71$ → Lanthanoids $n=6$, group = 3, Block f

⑤ if $90 \leq Z_{given} \leq 103$ Actinoids $n=7$ group = 3, Block f

⑥ if $104 \leq Z_{given} \leq 118$ group No = Last two digit of "Z", $n=7$, (Block) 104 – 112 (d)
113 – 118 p

Ex $Z = 33$ next inertgus = 36 $n=4$

Period no.(n) = 4

group no. = $33+18-36 = 15$

Block = p Block.

Ex-2 $Z = 57$ Next inert gus → 86 $n=6$

$n=6$

group No. $57+18-86$

$75-86 = -11$ ✗

$57+32-86$

$89-86 = 3$ ✓

Block = d

H.W

Atomic No. (Z)	Period	group	Block
68			
71			
95			
35			
83			
56			
95			
109			
111			

Case-II When e^- Configuration is given

* **Period no :-** maximum Value of "n" in given Configuration

$1s^2 2s^2 2p^6 \underbrace{3s^2\ 3p^5}_{n^{th}}$ $n=3$

* **Block :-** decided by Subshell in which Last-e^- enters.

* **group No.**

S-Block $\Rightarrow$ gp No $=$ ns e^-

p-Block $\Rightarrow$ gp No $=$ $12 + np\ e^-$

d-Block $\Rightarrow$ gp No. $=$ $ns + (n-1)d\ e^-$

f-Block $\rightarrow$ Always 3rd group

H.W

e⁻ configuration | Period no. | Block | group.

$[Xe]\ 6s^2$

$[Xe]\ 6s^2\ 4f^7\ 5d^1$

$[Ar]\ 4s^2\ 3d^{10}$

* $[Kr]\ 4d^{10}$

$[Rn]\ 7s^2\ 5f^{14}$.

$[Ne]\ 3s^2\ 3p^3$

$[Ar]\ 4s^2\ 3d^{10}\ 4p^2$

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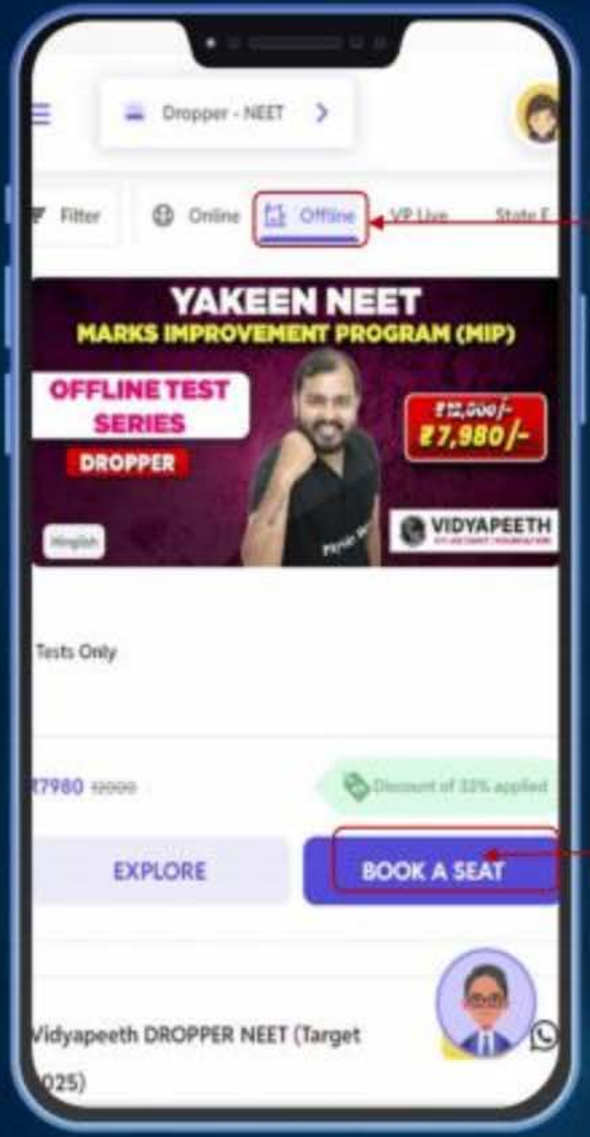

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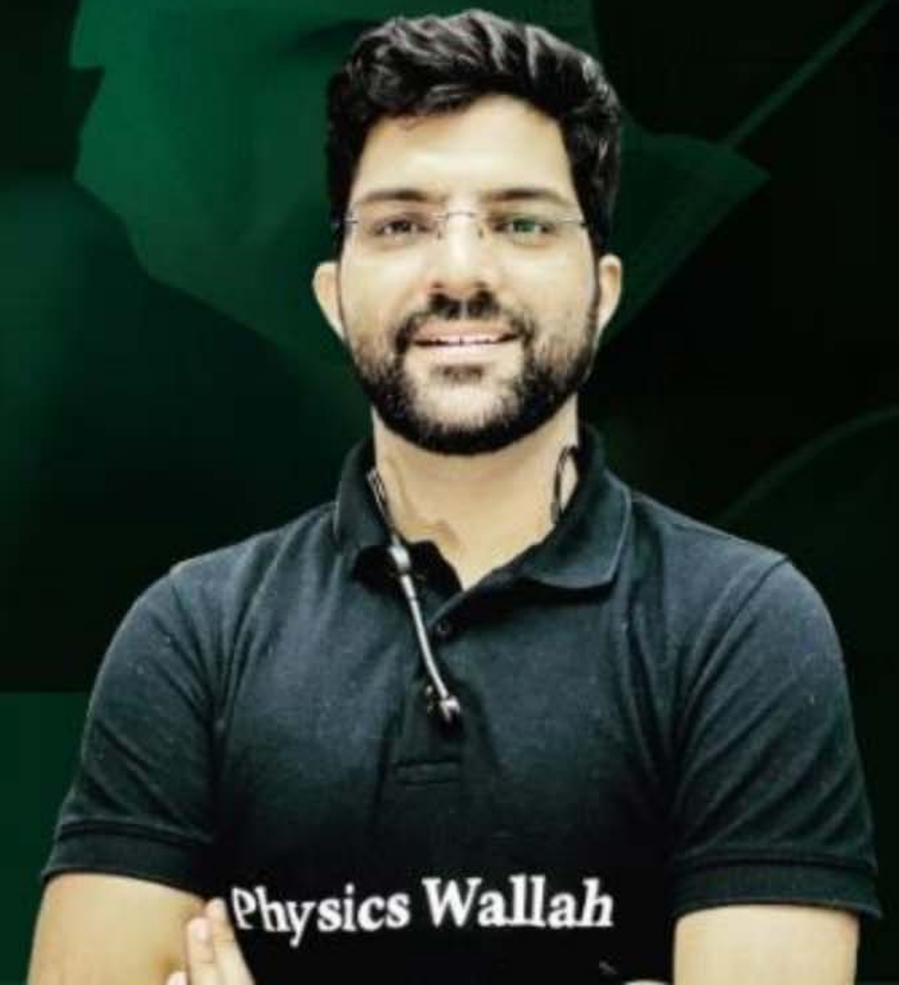
FOR NEET 2025

Lecture- 04 | Inorganic Chemistry

Classification of Elements and Periodicity in Properties



By - Mohit Dadheech (MD Sir)

Topics *to be covered*

1. Screening Effect & Effective Nuclear charge

H.W

Atomic No. (Z)	Period	group	Block
68	6	3	f
71	6	3	f
95	7	3	f
35	4	17	p
83	6	15	p
56	6	2	s
95	4	7	d
109	7	9	d
111	7	11	d

H.W

e⁻ configuration	Period no.	Block	group
$[Xe]\ \underline{6s^2}$	6	s	2 $(ns\,e^-)$
$[Xe]\ \underline{6s^2}\ 4f^7\ 5d^1$	6	f	3
$[Ar]\ \underline{4s^2}\ 3d^{10}$	4	d	12 $(ns\,e^- + (n-1)d\,e^-)$
$[Kr]\ 4d^{10}\ \underline{5s^0}$ ($_{36}$, $2 = 2d$, $46 - 36 = 10$)	~~4~~ 5	d	10 $(\rightarrow 1, \longrightarrow n)$
$[Rn]\ \underline{7s^2}\ 5f^{14}$	7	f	3
$[Ne]\ 3s^2\ \underline{3p^3}$ (np)	3	p	15 $(12 + np\,e^-)$
$[Ar]\ 4s^2\ 3d^{10}\ \underline{4p^2}$ (np)	4	p	14 $(12 + np\,e^-)$

NOTE

① If np e^- are present then p Block is Confirmed

$ns \rightarrow \underline{(n-2)f \rightarrow (n-1)d} \rightarrow (np)$

np^{1-6}

② For s-Block element $\bar{e}$ must not be present into $\underline{(n-2)f \ \& \ (n-1)d}$ subshells

$[Ar]\ 3d^5\ (4s^1)$ ns^1 ~~s-Block~~

$(n-1)d$ (n)

d-Block ✓ ∵ $\bar{e}$ are present in $(n-1)d$

$[Xe]\ 4f^4\ 5d^0\ (6s^2)$ ns^2 - ~~s-Block~~

$(n-2)f\ (n-1)d$

f-Block ✓ ∵ $\bar{e}$ are present in $(n-2)f$

QUESTION

Which of the following electronic configuration does not belong to same block as others :

A [Xe] $4f^{14}\ 5d^{10}\ 6s^2$ — d Block

B [Kr] $4d^{10}\ 5s^2$ — d-Block

C [Kr] $5s^2$ — s-Block.

D [Ar] $3d^6\ 4s^2$ — d-Block

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 5s^2$

$(n-4)$ $(n-3)$ $(n-2)$ $(n-1)^{th}$ n^{th}

QUESTION

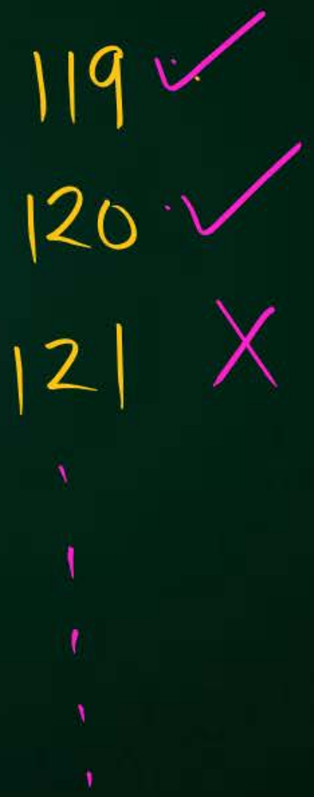
Which of the elements whose atomic number are given below, cannot be accommodate in the present set up of the long form of the periodic table

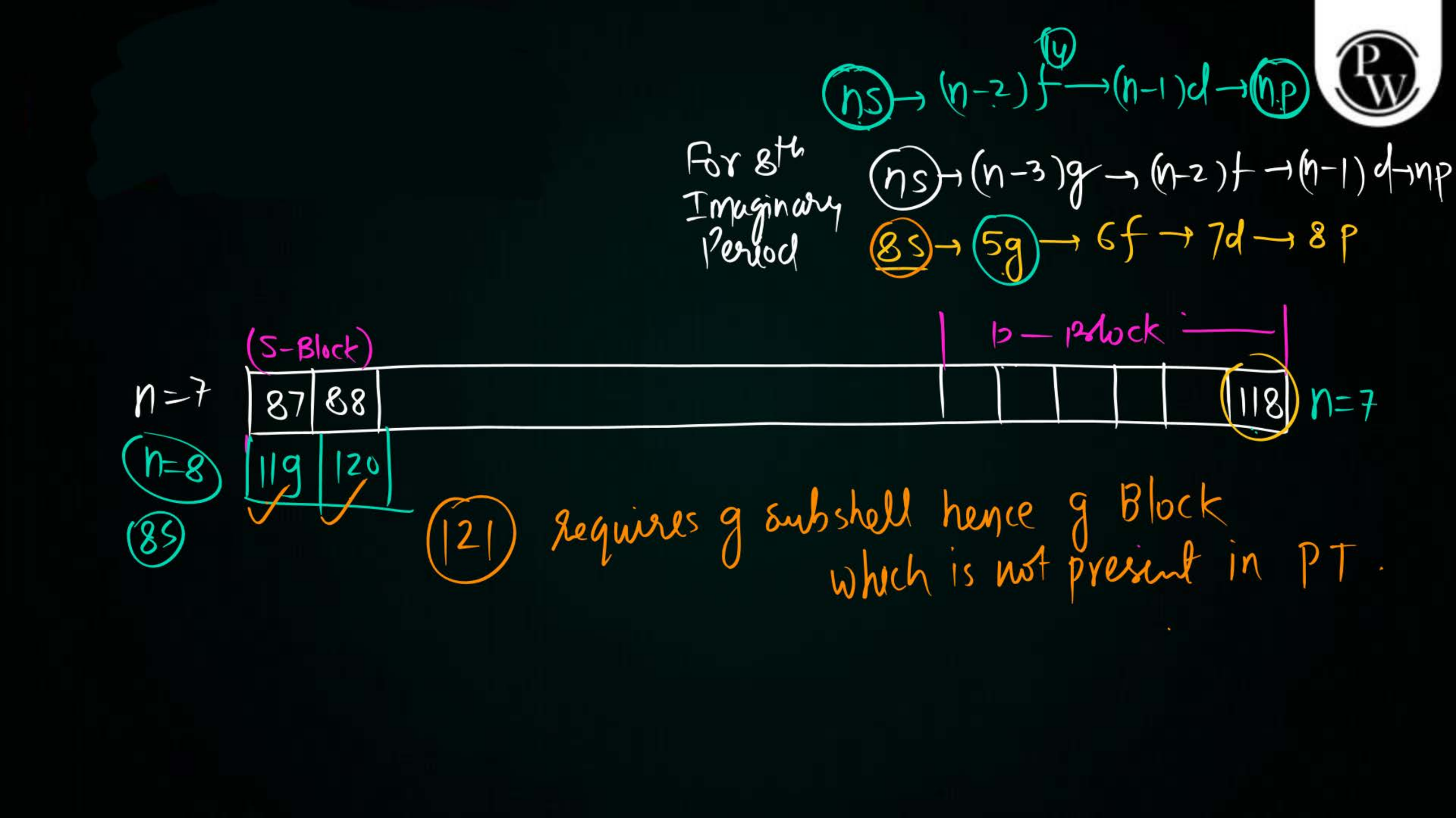
A 107

B 118

C 126

D 102




ns → (n-2)f (4) → (n-1)d → np
For 8th Imaginary Period
ns → (n-3)g → (n-2)f → (n-1)d → np
8s → 5g → 6f → 7d → 8p
(S-Block)
p-Block
n=7
87
88
118
n=7
n=8
119
120
8s
121 requires g subshell hence g Block which is not present in PT.

QUESTION

Minimum atomic number that can change the model of modern periodic table: (follow n + ℓ rule)

A 119

B 121

C 132

D 150

QUESTION

Which of the following electronic configurations in the outermost shell is characteristic of alkali metals

n = 4

A $(n-1)\ s^2p^0\ ns^2p^1$ ✗ $3s^2\ 3p^0\ 4s^2\ 4p^1$

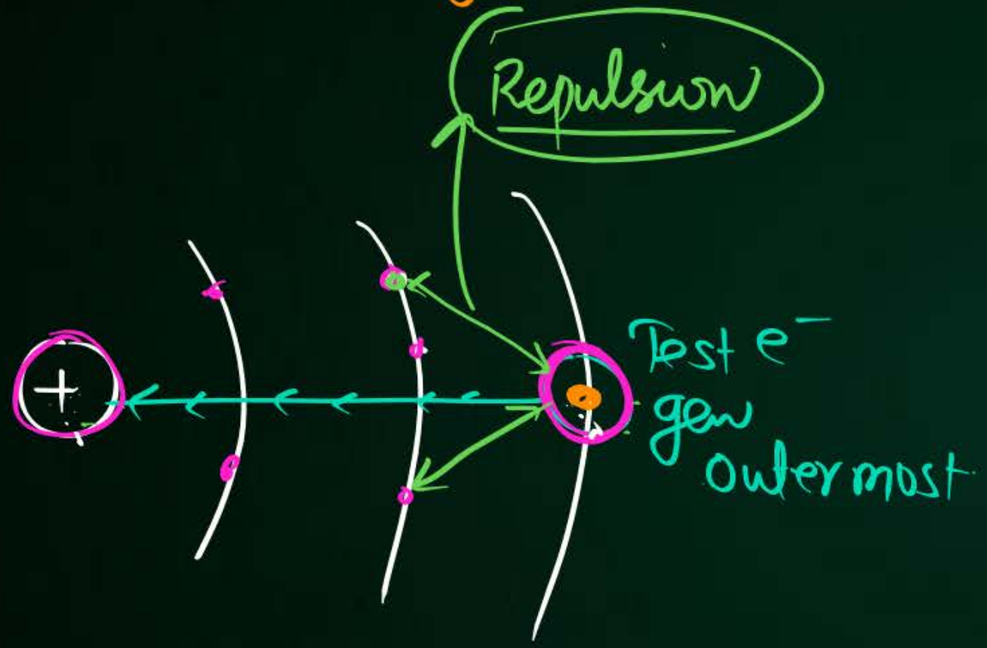
B $(n-1)\ s^2p^6d^{10}\ ns^1$ ✗ $3s^2\ 3p^6\ 3d^{10}\ 4s^1$ ($n-1$)d (n) ns^1 s-Block ✗ d-Block

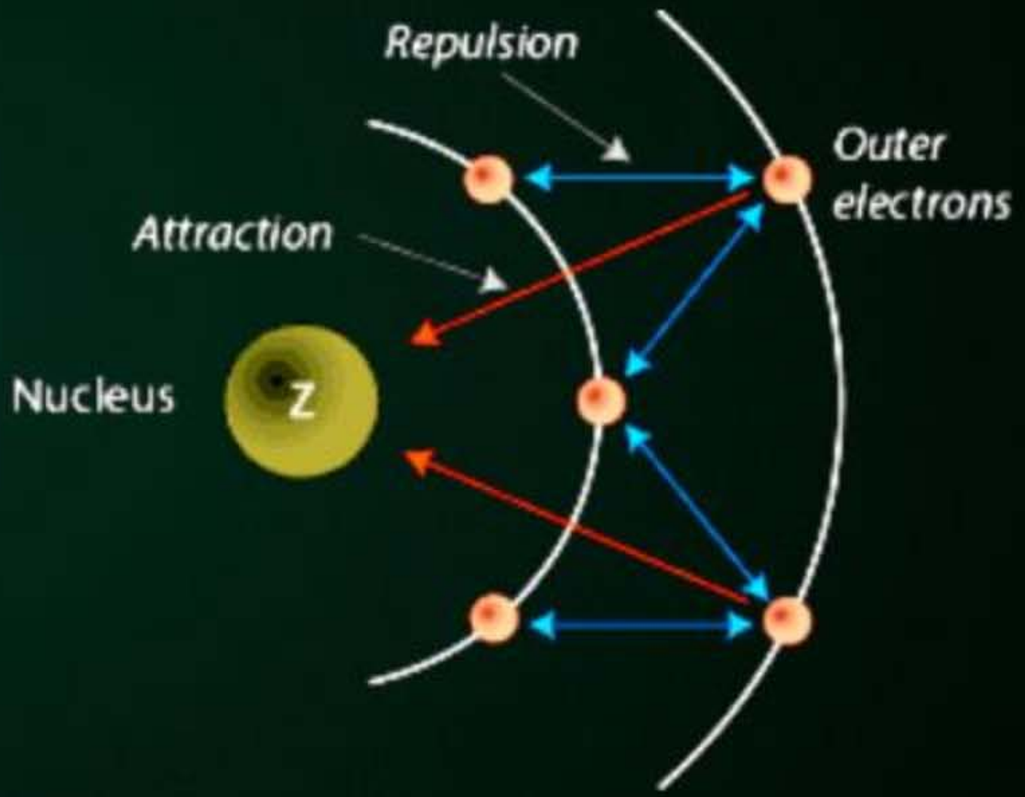
C $(n-1)\ s^2p^6\ ns^1$ $3s^2\ 3p^6\ 4s^1$ ✓ s-Block

D $ns^2np^6(n-1)d^{10}$ $4s^2\ 4p^6\ 3d^{10}$ $3d^{10}\ 4s^2\ 4p^6$ p-Block

Screening Effect & Effective Nuclear charge

or shielding





Screening / shielding Effect (σ)

Tendency of Inner shell's e^- to Protect outer test e^- From nuclear charge.

or

Repulsive force Exerted by inner e^- towards outermost test e^-

Effective Nuclear charge (Z_{eff})

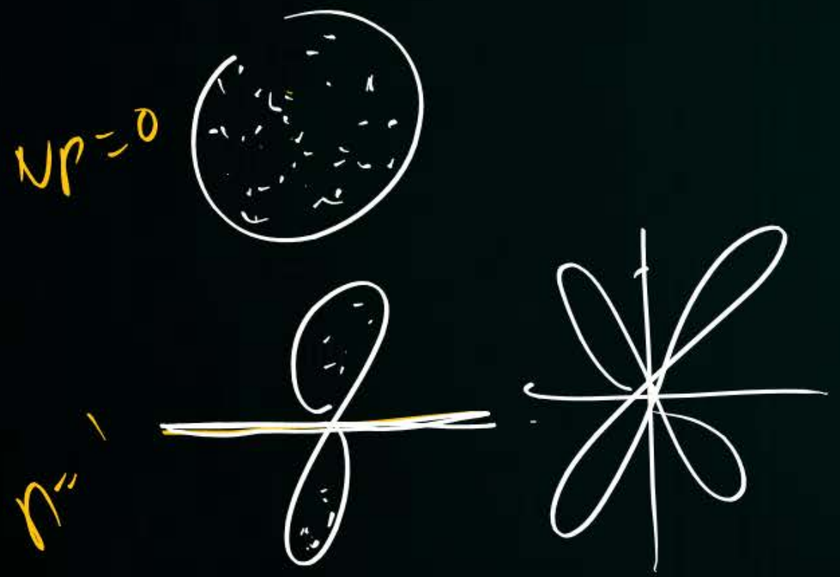
$$Z_{eff} = Z - \sigma$$

- Z_{eff}: Net force of Attraction
- Z: Total Attraction, no. of p^+
- σ: Repulsion.

$\Rightarrow$ Net Force of attraction on Outermost test e^-

Order of shielding

For different subshells of same shell :-



$$s > p > d > f$$

Poor shielding (σ)

Very poor shielding (σ)

↓

due to their diffused shape.

$\therefore$ $\bar{e}$ density Low

$s > p > \underbrace{d > f}_{\text{Poor } \sigma}$

$\uparrow Z_{eff} = Z - \textcircled{\sigma}\downarrow$

$Z_{eff} \propto \frac{1}{\sigma}$

$Z_{eff} \uparrow$ net attraction on outer $e^- \uparrow$

Contraction $\uparrow_{se} \longrightarrow$ Size $\downarrow$

Contraction

(TC) Transition Contraction
due poor σ of 3d e^-

(LC) Lanthanoid contraction
due to poor σ of 4f e^-

(AC) Actinoid Contra-
due to poor σ of 5f e^-

order of shielding 3d > 4f > 5f

Strength of Contraction T.C < L.C < A.C

THANK YOU

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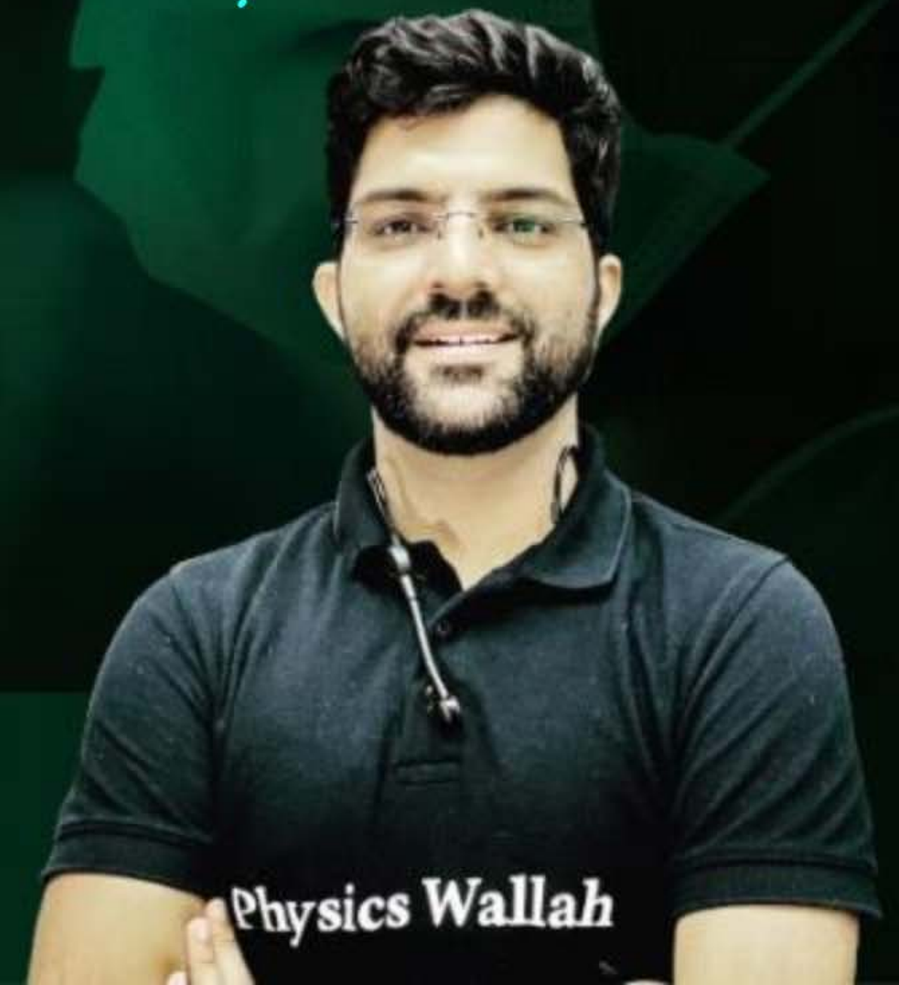
Lecture- 05 | Inorganic Chemistry

Classification of Elements and Periodicity in Properties



By - Mohit Dadheech (MD Sir)

Topics *to be covered*

1. Atomic radius (Size)

On the Basis of Vaules it has been found that :-

For S & P Block

* On moving Left to right in a period generally
  Zeff ↑se
* on moving top to bottom in a group. generally.
  Zeff remains Constant.

Period	Element	Li	Be	B	C	N	O	F
	Z_{eff}	1.30	1.95	2.60	3.25	3.90	4.55	5.20

+0.65 +0.65

Group	
Element	Z_{eff}
Li	1.30
Na	2.20
K	2.20
Rb	2.20
Cs	2.20
Fr	2.20

+0.90

Constant

More rise

L → R : n constant, σ ↑, Z_{eff} ↑↑

T ↓ B : n rise, σ ↑, Z_{eff} constant

Z_{eff} in Isoelectronic Species & ions of Same element

(1) Isoelectronic Species :—

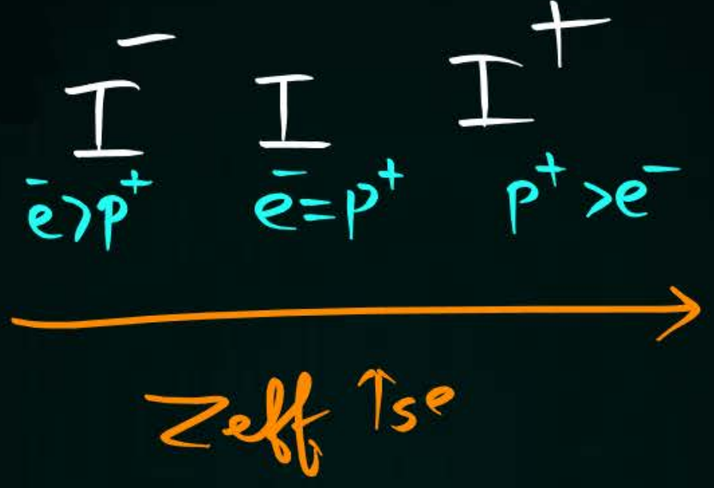
Isoelectronic → Same no. of e^-

	Al^{3+}	Mg^{2+}	Na^+	F^-	O^{2-}	N^{3-}
p^+	13	12	11	9	8	7
e^-	10	10	10	10	10	10

Z_{eff} ↓se.

Z_{eff} in isoelectronic $\propto$ $\frac{+ve}{-ve}$ (p^+ / e^-)

Ions of Same element

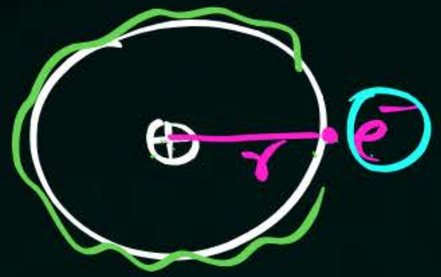


$O < O^+$ (Z_{eff})

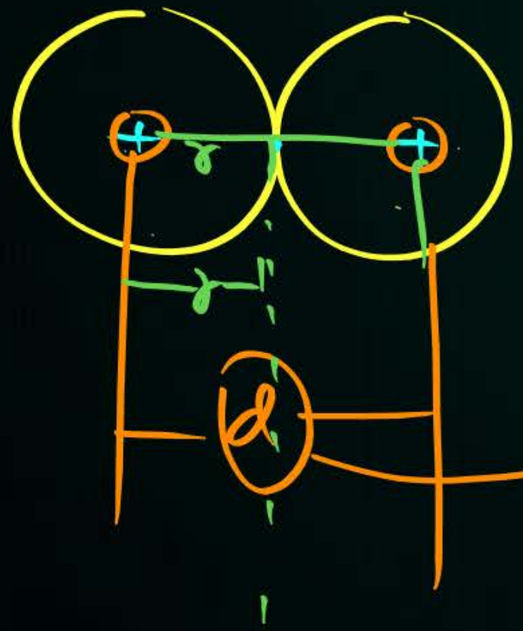
$O^+ < O^{2+}$ (Z_{eff}

$O > O^-$ (Z_{eff})

Size (Radius)



1.2×10^{-10} m



$r = \frac{d}{2}$

Internuclear distance (Bond length)

Size

Finding the Size of an atom is not Practically possible :—

Reasons

(i) Size of an atom is very Small (1.2×10^{-10} m)

(ii) there is no sharp boundary Present in an atom

Thats Why. Radius/Size Can be measured in Bonded/Combined state"

Atomic Radius

Half of distance (Internuclear distance) between the atoms in combined state.

Bonded state

Covalent Bond

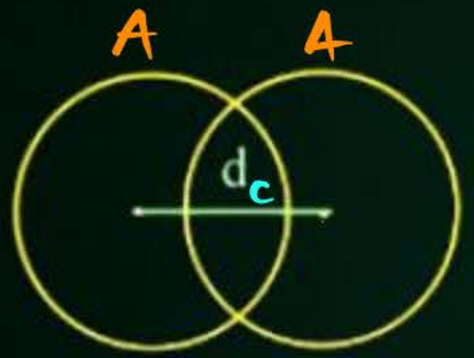
Metallic Bond

Vandrwaal Force

Ionic Bond.

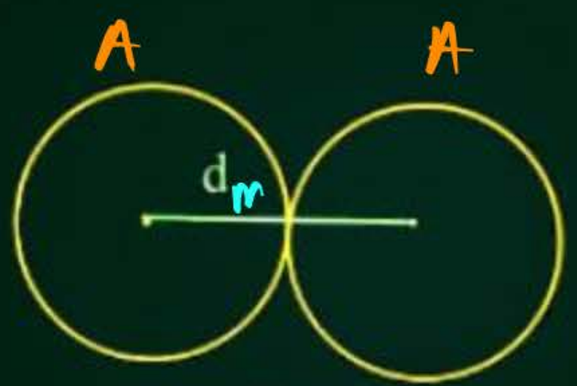
Types of Radius :

(i) Covalent radius
(ii) Metallic radius
(iii) Ionic radius
(iv) Vander waals radius



Covalent radius

$$r_C = \frac{d_c}{2}$$



Metallic radius

$$r_m = \frac{d_m}{2}$$

van der Waals Radius

$$r_v = \frac{d_v}{2}$$

For same element $r_c < r_m < r_v$

$r_v \approx 2 \times r_c$

Ionic radius / Crystal Radius :—

Neutral
$e^- = p^+$

Cation → $p^+ > e^-$. Z_{eff} ↑ . Contraction ↑, Size ↓ se (r^+)

∴ Cation is smaller than its Parent Species

Anion $e^- > p^+$

Z_{eff} ↓ se

Size (r^-) ↑ se

∴ Size of Anion is Larger than Parent species

Ex (i) $O^+ < O < O^-$

(ii) $F < F^-$

(iii) $Mg > Mg^{2+}$

(iv) $Al > Al^{3+}$

(v) $Cl^- > Cl$

(vi) $I^+ < I < I^-$

MDJ

Ionic Radius $\propto \frac{1}{Z_{eff}}$

Ionic Radius $\propto \frac{-ve}{+ve}$

Same can be apply For Isoelectronic series-

V. V. Imp for NEET

Size order in Isoelectronic Series :-

N^{3-} O^{2-} F^{-} Na^{+} Mg^{2+} Al^{3+} →

Z_{eff} ↑se Size ↓se.

Ex Cl^{-} S^{2-} K^{+} Ca^{2+} (size)

$18e^{-}$ $18e^{-}$ $18e^{-}$ $18e^{-}$

$S^{2-} > Cl^{-} > K^{+} > Ca^{2+}$

gen. trend of Size :-

(L → R) n constant, Z_{eff} ↑se Size ↓

(T ↓ B) n ↑ (shell no.)

Size ↑se

Ex

Li > Be > B > C > N > O > F <<< Ne

Na > Mg > Al > Si > P > S > Cl <<< Ar

Inert gas

Vanderwaal Radius (Max. Size)

give Correct order of Size in Following.

(i) $Mg > Al > \underset{10e^-}{Mg^{2+}} > \underset{10e^-}{Al^{3+}}$

(ii) $Li < Na < K < Rb < Cs$

(iii) $F < Cl < Br < I$

(iv) $N < P < As < Sb$

(v) $C < Si < Ge < Sn$

(vi) $O < S < Se < Te$

(vii) $He < Ne < Ar < Kr < Xe$

(viii) $F^- > F$

(ix) $F^- < Cl^- < Br^- < I^-$

(x) $Li^+ < Na^+ < K^+ < Rb^+$

QUESTION

The ions O^{2-}, F^{-}, Na^{+}, Mg^{2+} and Al^{3+} are isoelectronic. Their ionic radii show

[AIPMT 2003]

A an increase from O^{2-} to F^{-} and then decrease from Na^{+} to Al^{3+}

B a decrease from O^{2-} to F^{-} and then increase from Na^{+} to Al^{3+}

C a significant increase from O^{2-} to Al^{3+}

D a significant decrease from O^{2-} to Al^{3+}

QUESTION

Ionic radii are :- [AIPMT 2004]

A Directly proportional to square of effective nuclear charge

B Inversely proportional to effective nuclear charge

C Inversely proportional to square of effective nuclear charge

D Directly proportional to effective nuclear charge

QUESTION

Among the elements Ca, Mg, P and Cl, the order of increasing atomic radii is :-

[AIPMT 2010]

A. Cl < P < Mg < Ca

B. P < Cl < Ca < Mg

C. Ca < Mg < P < Cl

D. Mg < Ca < Cl < P

Mg > P > Cl

Ca

QUESTION

The correct order of the decreasing ionic radii among the following isoelectronic species is :-

[AIPMT 2010]

H.W

A $K^+ > Ca^{2+} > Cl^- > S^{2-}$

B $Ca^{2+} > K^+ > S^{2-} > Cl^-$

C $Cl^- > S^{2-} > Ca^{2+} > K^+$

D $S^{2-} > Cl^- > K^+ > Ca^{2+}$

QUESTION

Identify the wrong statement in the following :

(H.W)

[AIMPT Pre 2011]

A. Atomic radius of the elements increases as one moves down the first group of the periodic table

B. Atomic radius of the elements decreases as one-moves across from left to right in the 2^{nd} period of the periodic table

C. Amongst isoelectronic species, smaller the positive charge on the cation, smaller is the ionic radius

D. Amongst isoelectronic species, greater the negative charge on the anion, larger is the ionic radius

QUESTION

Which of the following orders of ionic radii is correctly represented

[AIPMT 2014]

A $H^- > H^+ > H$

B $Na^+ < F^- < O^{2-}$

C $F^- > O^{2-} > Na^+$

D $Al^{3+} > Mg^{2+} > N^{3-}$

QUESTION

Be^{2+} is isoelectronic with which of the following ions ? [AIPMT 2014]

H.W

A H^+

B Li^+

C Na^+

D Mg^{2+}

QUESTION

Consider the isoelectronic species, Na^+, Mg^{2+}, F^- and O^{2-}. The correct order of increasing length of their radii is _____.

A $F^- < O^{2-} < Mg^{2+} < Na^+$

B $Mg^{2+} < Na^+ < F^- < O^{2-}$

C $O^{2-} < F^- < Na^+ < Mg^2$

D $O^{2-} < F^- < Mg^{2+} < Na^+$

H.W

QUESTION

Which of the following is the correct order of size of the given species.

A $I > I^- > I^+$

B $I^+ > I^- > I$

C $I > I^+ > I$

D $I^- > I > I^+$

H.W

NCERT KI CHOTI CHOTI MAGAR MOTI BAATEIN

Fill in the Blanks :

An electron in an atom is characterised by a set of four Quantum Numbers.

An element's location in the Periodic Table reflects the quantum numbers of the last Orbital filled.

Successive period in the Periodic Table is associated with the filling of the next higher principal energy level. True

Number of elements in each period is twice the number of Orbital available in the energy level that is being filled.

The elements of Group 1 (alkali metals) and Group 2 (alkaline earth metals) which have ns^1 & ns^2 outermost electronic configuration respectively.

Covalent Radius

One practical approach to estimate the size of an atom of a non-metallic element is to measure the distance between two atoms when they are bound together by a single bond in a covalent molecule and from this value, the "Covalent Radius" of the element can be calculated. For example, the bond distance in the chlorine molecule (Cl_2) is 198 pm and half this distance (99 pm), is taken as the atomic radius of chlorine.

$d_C = 198$ $\quad r_C = \frac{198}{2}$

For metals, we define the term "Metallic Radius" which is taken as half the internuclear distance separating the metal cores in the metallic crystal. For example, the distance between two adjacent copper atoms in solid copper is 256 pm; hence the metallic radius of copper is assigned a value of 128 pm.

d_M $\quad r_M = d_M/2$

For simplicity, in this book, we use the term Atomic Radius to refer to both covalent or metallic radius depending on whether the element is a non-metal or a metal.

The atomic size generally decreases across a period for the elements. It is because within the period the outer electrons are in the same valence shell and the effective nuclear charge increases as the atomic number increases resulting in the increased attraction of electrons to the nucleus. Within a family or vertical column of the periodic table, the atomic radius increases regularly with atomic number.

Li < Na < K < Rb < Cs F < Cl < Br < I

For alkali metals and halogens, as we descend the groups, the principal quantum number (n) increases and the valence electrons are farther from the nucleus. This happens because the inner energy levels are filled with electrons, which serve to shield the outer electrons from the pull of the nucleus. Consequently the size of the atom increases as reflected in the atomic radii.

Note that the atomic radii of noble gases are not considered here. Being monoatomic, their (non-bonded radii) values are very large. In fact radii of noble gases should be compared not with the covalent radii but with the van der Waals radii of other elements.

THANK YOU

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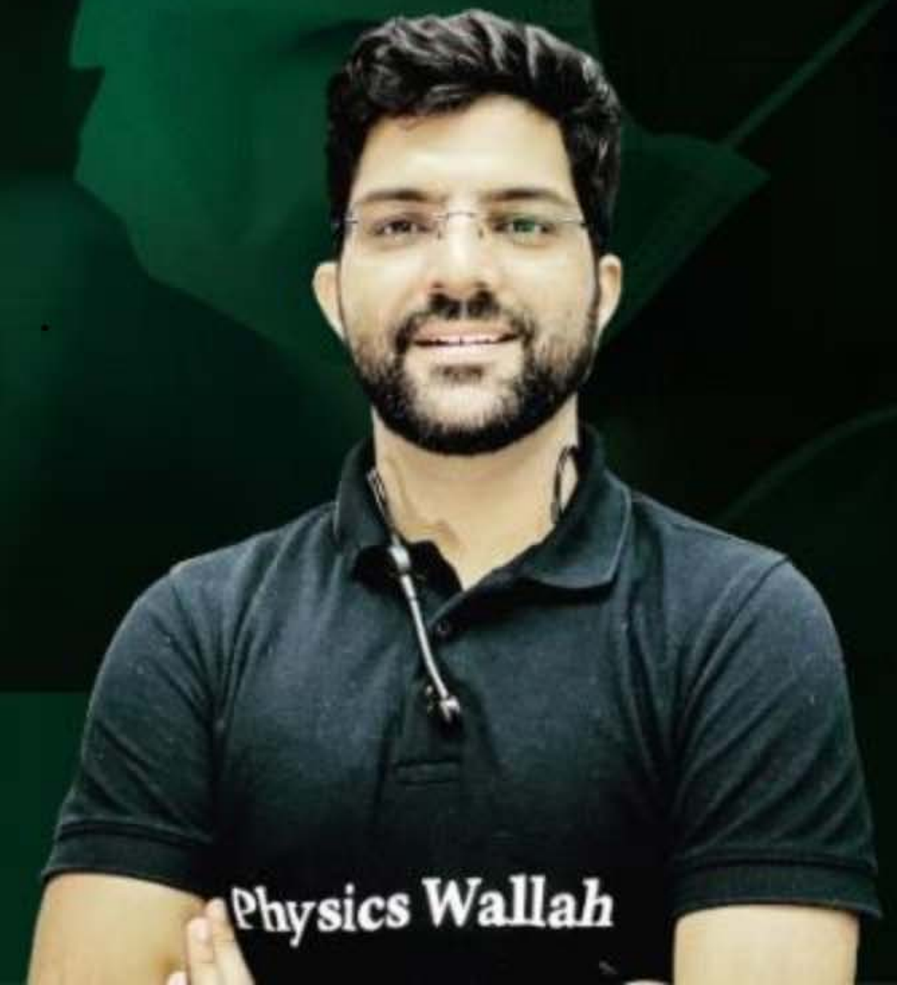
FOR NEET 2025

Lecture- 06 | Inorganic Chemistry

Classification of Elements and Periodicity in Properties

By - Mohit Dadheech (MD Sir)



Topics *to be covered*

1. Blockwise size
2. Ionization Energy

Blockwise Size

S-Block (No Exception)

group-1	group-2
Li	Be
↑	↑
Na	Mg
↑	↑
K	Ca
↑	↑
Rb	Sr
↑	↑
Cs	Ba

T → B Size ↑se ($\because n \uparrow$)

L → R Size ↓se (in a particular period)
($\because Z_{eff} \uparrow$se)

Ex

Li > Be

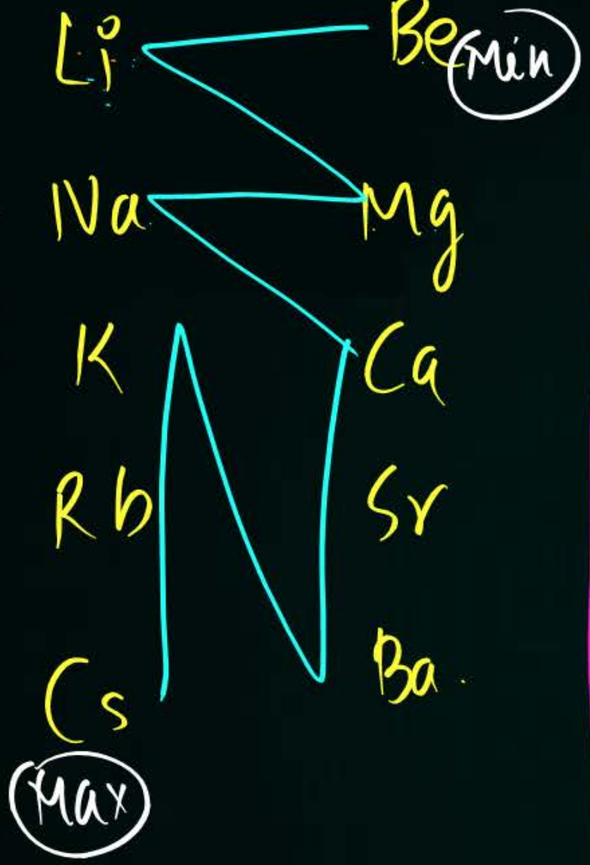
Na > Mg

K > Ca

- - -

- - -

Size order For Complete S-Block



Same trick can be applied for their respective ions also. With only one change.

$$Li^{+} \geq Mg^{2+}$$

$$Be^{2+} < Mg^{2+} < Li^{+} < Na^{+} < Ca^{2+} < Sr^{2+} < Ba^{2+}$$

$$< K^{+} < Rb^{+} < Cs^{+}$$

p- Block

From Gsoup 14th to 18th their is no exception Means Size ↑se down the group.

13th

B
Al
Ga
In
Tl

$[Ne]\,3s^2\,3p^1$

$[Ar]\,3d^{10}\,4s^2\,4p^1$

Sc $2\,1\;d^1$ — Zn $3\,0\;d^{10}$ — 31 — Ga

10 $d\bar{e}$ have poor ⌐

Zeff ↑se, Contraction ↑, Size ↓se

Transition contraction

d-Block

(L → R) only 3d series

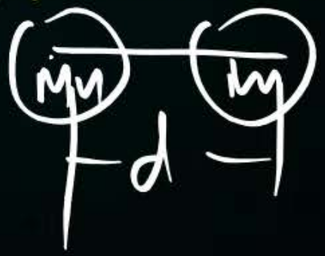
order based on data given in NCERT 12th Part-I

$Sc < Ti < V < Cr > Mn < Fe \simeq Co \simeq Ni < Cu < Zn$

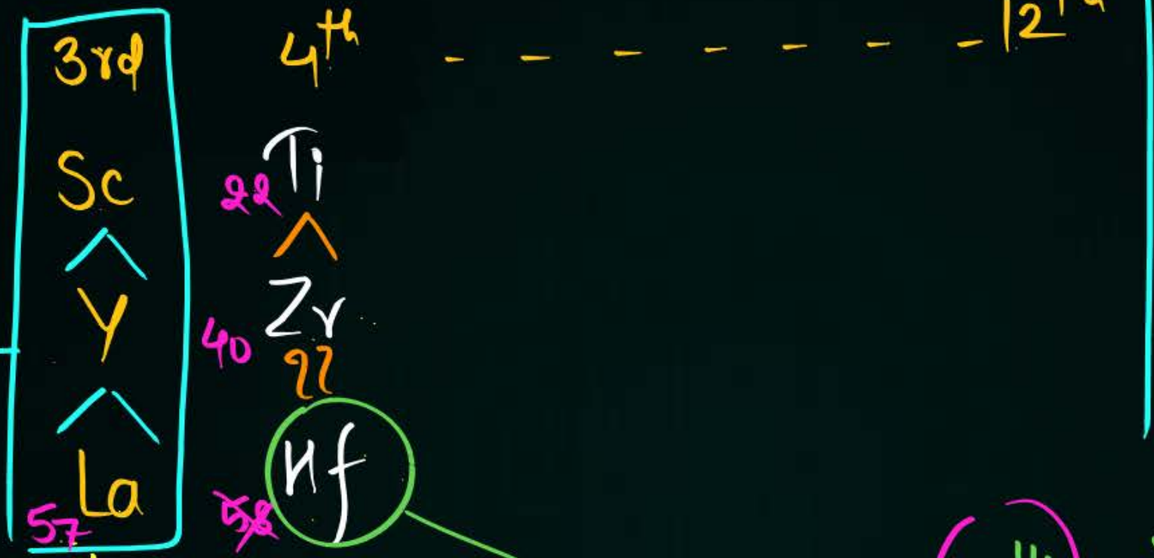
* $Sc > Zn$
* $Mn \simeq Zn$

$Mn \rightarrow 3d^5 4s^2$

- Stable Half Filled Configuration
- less tendency to participate in Metallic Bonding
- Weak Metallic Bonding
- More internuclear distance → r_m ↑ Size ↑



T → B d-Block



Except 3rd group

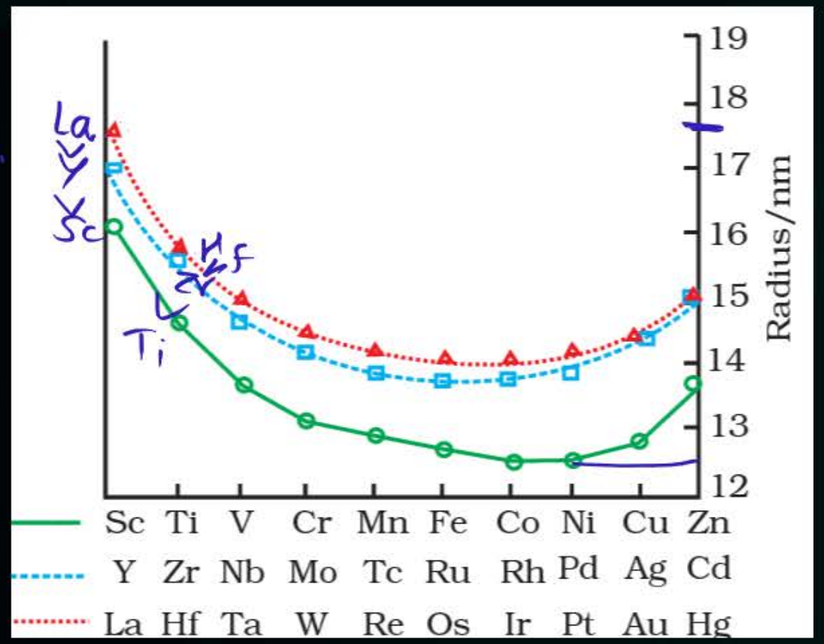
Size of 5d series elements become similar to 4d series due to Lanthanoid Contraction

Normal Top to Bottom Size ↑se

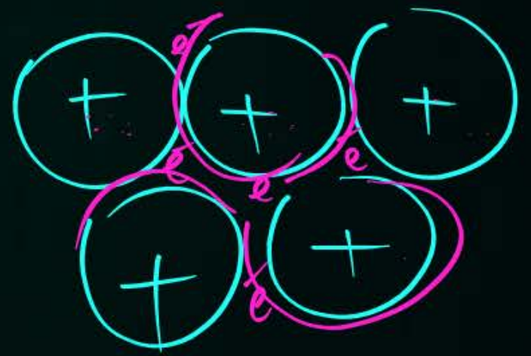
58 to 71
Lanthanoids
$4f e^-$

$[Xe]\ 4f^{14}\ 5d^2\ 6s^2$

$14\ f e^-$ have Extremely Poor shielding
$\sigma \downarrow$ $z_{eff} \uparrow$ Contraction ↑ Size ↓



due to Similarities in Size d-Block metals are used in alloy formation.



f-Block Lanthanoids (L→R)

(M) Eu > La > Ce > Pr > Nd > Pm > Sm < Eu > Gd > Tb > Dy > Ho > Er > Tm > Yb > Lu.

- Stable Configuration
- Loose Packing :
  - Weak Metallic Bonding, Size ↑

(M^{3+}) $La^{3+} > \ldots\ldots > Lu^{3+}$

In Lanthanoids Size ↓se L→R in (M) as well as M^{3+} (Ionic Size)

due to ↑se in Zeff

↳ Reason $\bar{e}$ are filling in 4f subshell

σ↓ → Zeff ↑se (Lanthanoid Contra

QUESTION

Because of lanthanoid contraction, which of the following pairs of elements have nearly same radii? (Numbers in the brackets are atomic numbers).

[AIPMT 2015]

A Zr (40) and Nb (41)

B Zr (40) and Hf (72)

C Zr (40) and Ta (73)

D Ti (22) and Zr (40)

QUESTION

The correct order of atomic radii in group 13 elements is : [NEET-2018]

A $B < Al < In < Ga < Tl$

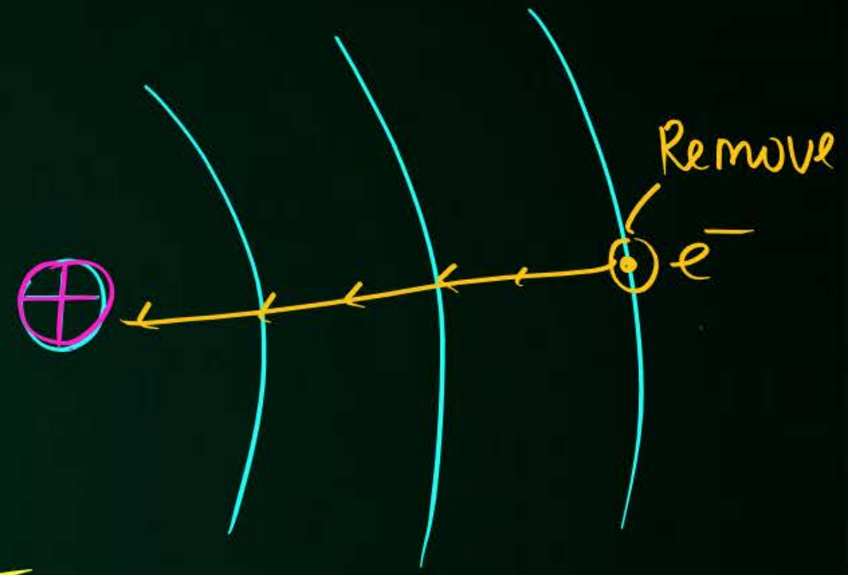
B $B < Al < Ga < In < Tl$

C $B < Ga < Al < Tl < In$

D $B < Ga < Al < In < Tl$

Ionization Energy I.E / I.P

↳ Minimum Energy required to remove most loosely bounded $\bar{e}$ From an isolated gaseous atom



↳ For Neutral atoms & Cations removal of $\bar{e}$ is always Endothermic [ΔH +ve]

$$\Delta H_i \Rightarrow +ve$$

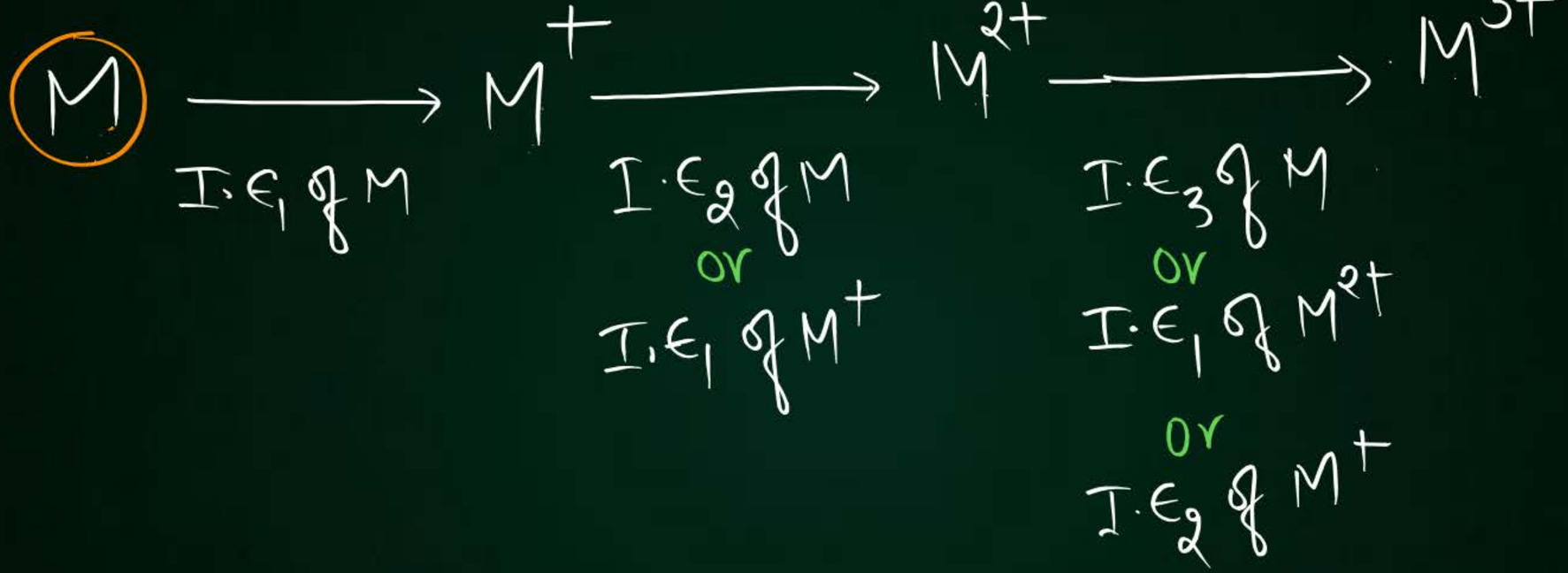
Value of Successive I.E for an Element :-

$M \xrightarrow{I.E_1} M^{+} \xrightarrow{I.E_2} M^{2+} \xrightarrow{I.E_3} M^{3+}$

$\bar{e} = p^{+}$ $\quad \bar{e} < p^{+}$ $\quad \bar{e} << p^{+}$ $\quad \bar{e} <<< p^{+}$

$Z_{eff} \uparrow_{se.} \Rightarrow$ Value of Successive I.E $\uparrow_{se.}$

$I.E_1 < I.E_2 < I.E_3 - - - - - -$


M
M+
M2+
M3+
I.E1 of M
I.E2 of M
or
I.E1 of M+
I.E3 of M
or
I.E1 of M2+
or
I.E2 of M+

QUESTION

In which of the following the energy change corresponds to first ionization potential :-

A $X_{(g)} \rightarrow X^{+}_{(g)} + e$

B $X_{2(g)} \rightarrow X^{+}_{(g)} + e$

C $X_{(s)} \rightarrow X^{+}_{(g)} + e$

D $X_{(aq)} \rightarrow X^{+}_{(aq)} + e$

QUESTION

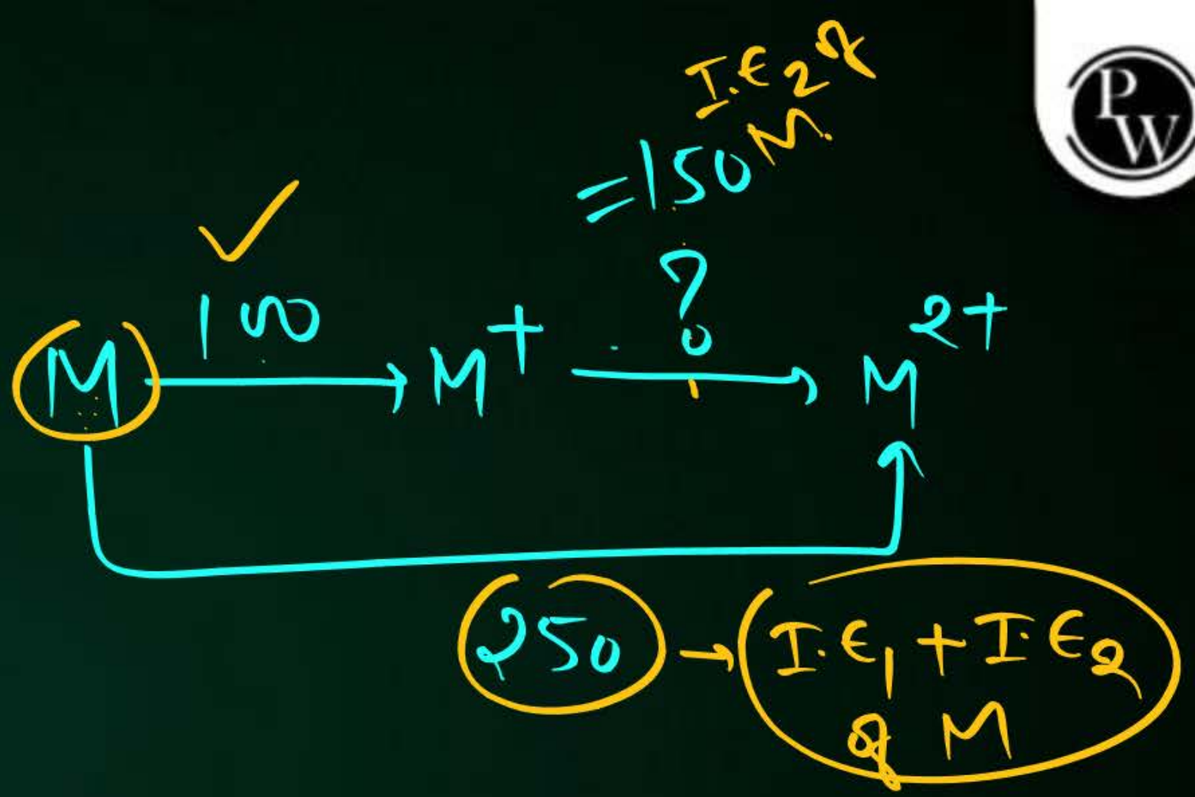
$M(g) \rightarrow M^{+}(g) + e^{-}$, $\Delta H = 100$ eV,
$M(g) \rightarrow M^{2+}(g) + 2e^{-}$, $\Delta H = 250$ eV
Which is incorrect statements :-

A IE_1 of M(g) is 100 eV ✓

B IE_2 of M(g) is 150 eV ✓

C IE_2 of M(g) is 250 eV ✗

D None



THANK YOU

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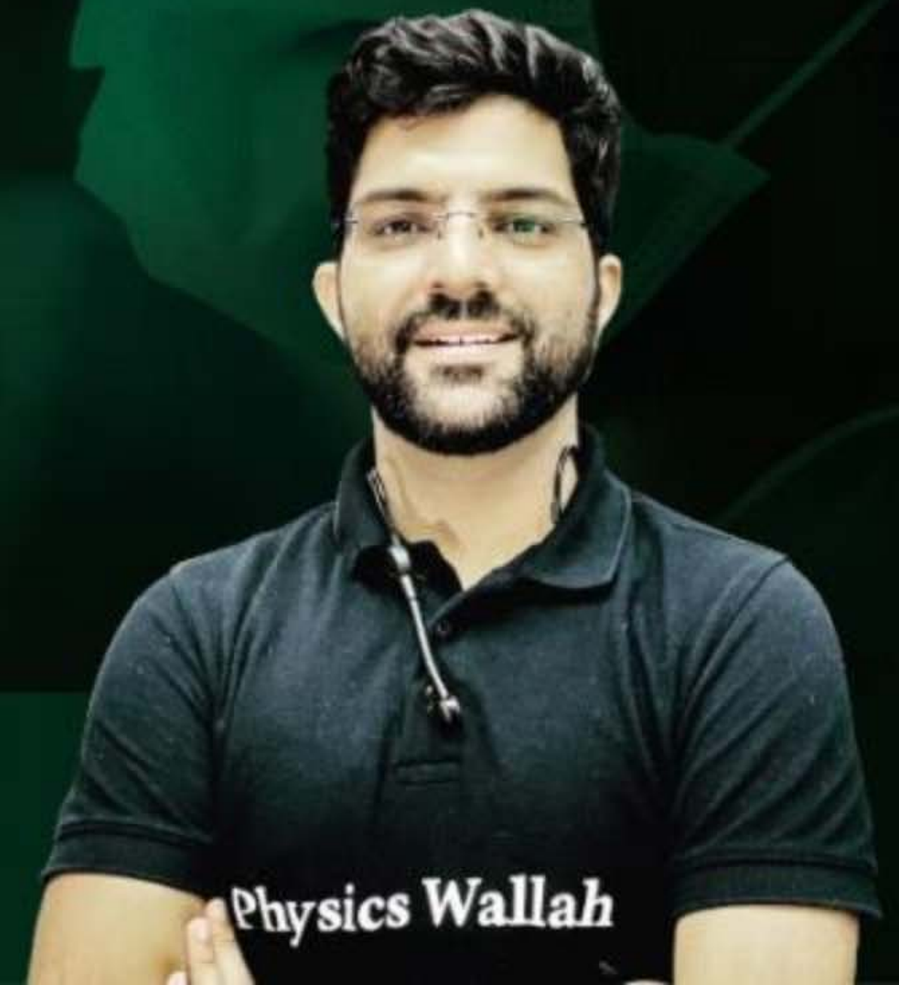
FOR NEET 2025

Lecture-07 | Inorganic Chemistry

Classification of Elements and Periodicity in Properties

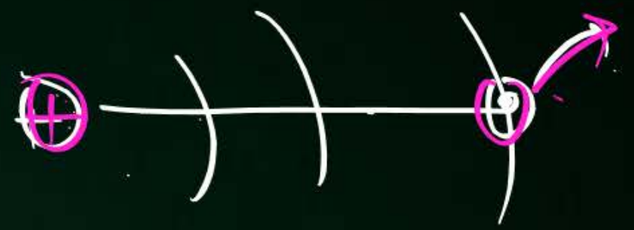


By - Mohit Dadheech (MD Sir)

Topics *to be covered*

1. Ionization Energy
   - Factors & Imp orders
   - 2nd I.E

Factors affecting I.E.



(1) Size :— $I.E \propto \frac{1}{Size}$

(2) Z_{eff} :— $I.E \propto Z_{eff}$

(3) Stable Configurations
- Fully Filled → np^6 Inert gas, Max I.E in a Period.
- Half filled → np^3 I.E ↑ more than adjacent np^4 Configuration

$np^3 > np^4$

Ex.1 $2p^3 > 2p^4$
N > O

Ex.2 $3p^3 > 3p^4$
P > S

(4) Penetration Power :—

$ns > np > nd > nf$

I.E

$ns^2 > np^1$

Be > B

$2s^2$ $2p^1$

Mg > Al

$3s^2$ > $3p$

Order of I.E

2nd Period

He ⇒ n=1, $1s^2$ ⇒ Max. I.E in P.T

Li < Be > B < C < N > O < F < Ne

Li: $2s^1$ | Be: $2s^2$ | B: $2p^1$ | C: $2p^2$ | N: $2p^3$ | O: $2p^4$ | F: $2p^5$ | Ne: $2p^6$

Be: $2s^2$, B: $2p^1$ → P.P

N: $2p^3$, O: $2p^4$ → Half filled stability

Ne: $2p^6$ → Fully Filled Max I.E

Li < B < Be < C < O < N < F < Ne

3rd Period

Na < Mg > Al < Si < P > S < Cl < Ar

Na: $3s^1$ | Mg: $3s^2$ | Al: $3p^1$ | Si: $3p^2$ | P: $3p^3$ | S: $3p^4$ | Cl: $3p^5$ | Ar: $3p^6$

Mg: $3s^2$, Al: $3p^1$ → P.P

P: $3p^3$, S: $3p^4$ → Half filled.

→ Na < Al < Mg < Si < S < P < Cl < Ar

For n^{th} period

$(n = 2/3)$

MDJ

$ns^2 > np^1$

$ns^1 < np^1 < ns^2 < np^2 < np^4 < np^3 < np^5 < np^6$

$np^1 < ns^2$: P.P.

$np^4 < np^3$: Half filled

QUESTION

If the graph is plotted between atomic numbers and ionisation potential. Which group of element occupy the lowest position on the curve :–

A Alkaline earth metal

B Inert gas

C Actinides

D Alkali metals

ns¹

QUESTION

IP is influenced by -

$Z_{eff} \propto \frac{1}{\sigma}$

A Size of atom

B Effective nuclear charge

$Z_{eff} \propto I.E$

$I.E \propto \frac{1}{\sigma}$

C Electrons present in inner shell (σ)

D All

How to write $I.E_2$ order

$I.E_1 \rightarrow$ 1^{st} e^- removal process

$I.E_2 \longrightarrow$ 2^{nd} e^- removal process (1^{st} Nikal Chuka Hai)

$I.E_2$ of C = 2^{nd} e^- removal

$$C \xrightarrow[I.E_1 \text{ of } C]{} C^+ \xrightarrow[\text{or } I.E_1 \text{ of } C^+]{I.E_2 \text{ of } C} C^{2+}$$

Same

C^+ $2p^1$ < N^+ $2p^2$ ($I.E_1$)

or

C $2p^2$ $2p^1$ < N $3p^3$ $2p^2$ ($I.E_2$)

Ex-1

$O < F$ $(I.E_1)$

$2p^4$ $2p^5$

$O > F$ $(I.E_2)$

~~$2p^4$~~ ~~$2p^5$~~

$2p^3 > 2p^4$

Halffilled

Ex. 2 C N O F $(I.E_2)$

~~$2p^2$~~ ~~$2p^3$~~ ~~$2p^4$~~ ~~$2p^5$~~

$2p^1$ $2p^2$ $2p^3$ $2p^4$

$C < N < F < O$

Ex.3 Na Mg Al Si ($I.E_2$)

$2p^6$ ~~$3s^1$~~ ~~$3s^2$~~ ~~$3p^1$~~ ~~$3p^2$~~

$2p^6$ $3s^1$ $3s^2$ $3p^1$ $\Rightarrow$ $3s^1 < 3p^1 < 3s^2 < 2p^6$

pp

Max ∵ Full filled

$-n=2$

Size ↓

$Mg < Si < Al < Na$

I.E order in Isoelectronic Series & Ions of same element

Isoelectronic Species :-

N^{3-} O^{2-} F^- Na^+ Mg^{2+} Al^{3+} →

Z_{eff} ↑ I.E ↑

Ions of same element

O^{2+} O^+ O O^- O^{2-} →

Z_{eff} ↓ I.E ↓

Ex.

$Cl > Cl^-$ (I.E)

$3p^5 \quad 3p^6$

$3p^5 < 3p^6$ Not valid

For Same element Ions

Consider charge & Z_{eff} only

$Ne < Ne^+$ (I.E)

$2p^6 \quad 2p^5$

$2p^6 > 2p^5$

QUESTION

Which of the following has 2^{nd} IP < I^{st} IP

A Mg

B Ne

C C

D None

$M \xrightarrow{\varepsilon_1} M^{+} \xrightarrow{\varepsilon_2} M^{2+} \xrightarrow{\varepsilon_3} M^{3+}$

$\varepsilon_1 < \varepsilon_2 < \varepsilon_3 - - -$

QUESTION

The second ionization potentials in electron volts of oxygen and fluorine atoms are respectively given by :-

A 35.1, 38.3

B 38.3, 38.3

C 38.3, 35.1

D 35.1, 35.1

$O < F \quad (I.E_1)$

But

$I.E_2 \Rightarrow \quad O > F$

QUESTION

Which of the following electronic configuration an atom has the lowest ionization enthalpy ?

[AIPMT 2007]

A $1s^2\ 2s^2\ 2p^3$

B $1s^2\ 2s^2\ 2p^6\ 3s^1$ Lowest

C $1s^2\ 2s^2\ 2p^6$

D $1s^2\ 2s^2\ 2p^5$

QUESTION

Amongst the elements with following electronic configurations, which one of them may have the highest ionization energy ? **[AIPMT 2009]**

A $Ne[3s^2 3p^1]$

B $Ne[3s^2 3p^3]$

C $Ne[3s^2 3p^2]$

D $Ar[3d^{10} 4s^2 4p^3]$

Lowest

QUESTION

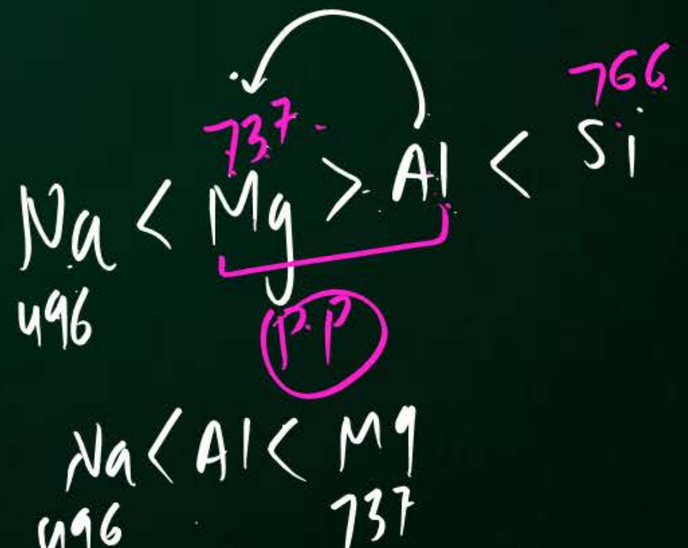
The 1st Ionization enthalpy of Na, Mg and Si are 496, 737, 766 kJ mol^{-1} respectively then what will be the 1st ionization enthalpy of Al in kJ mol^{-1} : **[AIIMS 2013]**

A. > 766 kJ mol^{-1}

B. > 496 and < 737 kJ mol^{-1}

C. > 737 and < 766 kJ mol^{-1}

D. 496 kJ mol^{-1}



QUESTION

For the second period elements the correct increasing order of first ionization enthalpy is : [NEET-2018]

A Li < Be < B < C < N < O < F < Ne

B Li < B < Be < C < O < N < F < Ne

C Li < B < Be < C < N < O < F < Ne

D Li < Be < B < C < O < N < F < Ne

QUESTION

The first ionization enthalpies of Na, Mg, Al and Si are in the order :

(H.W)

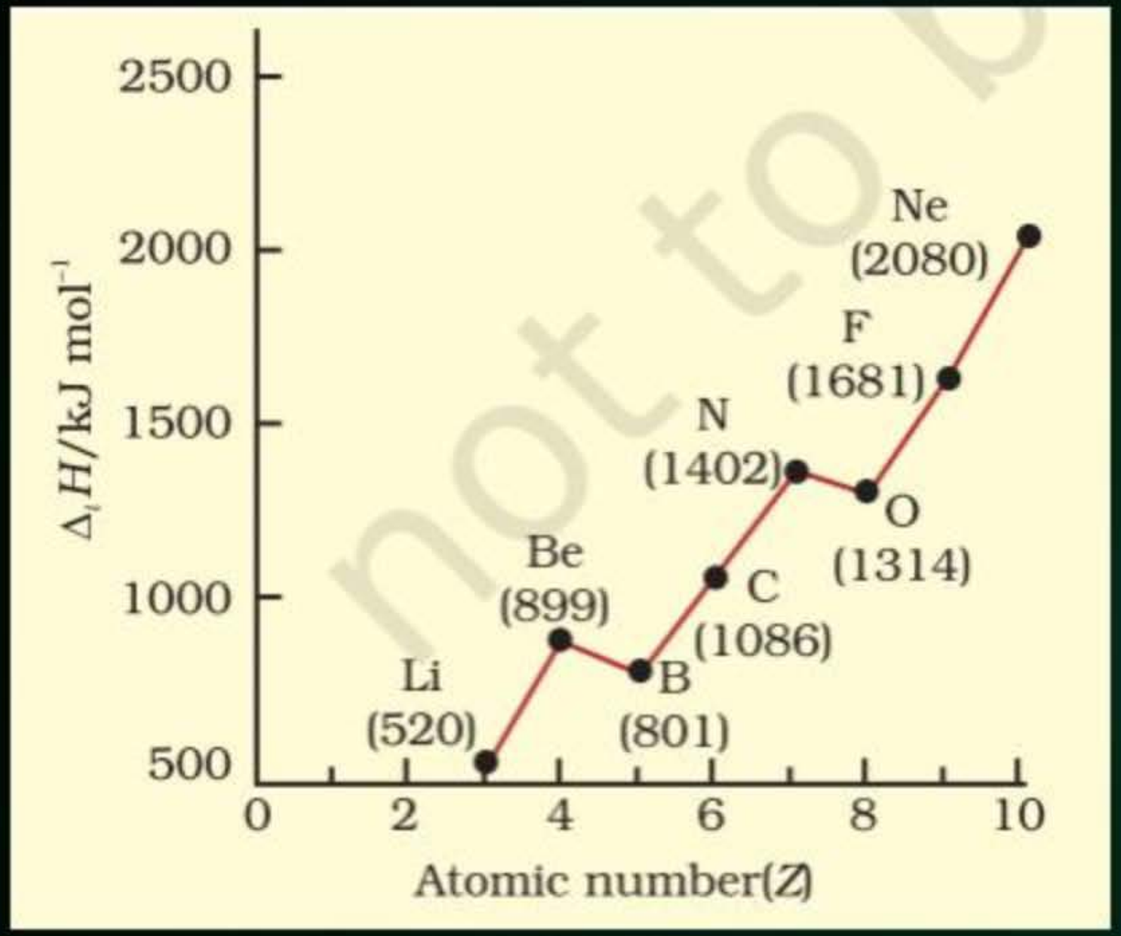
A $Na < Mg < Si < Al$

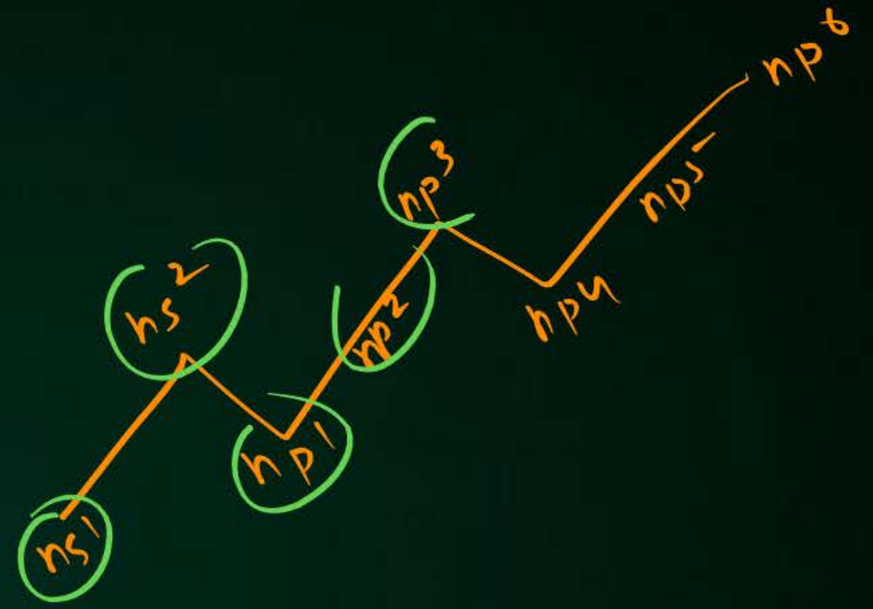
B $Na > Mg > Al > Si$

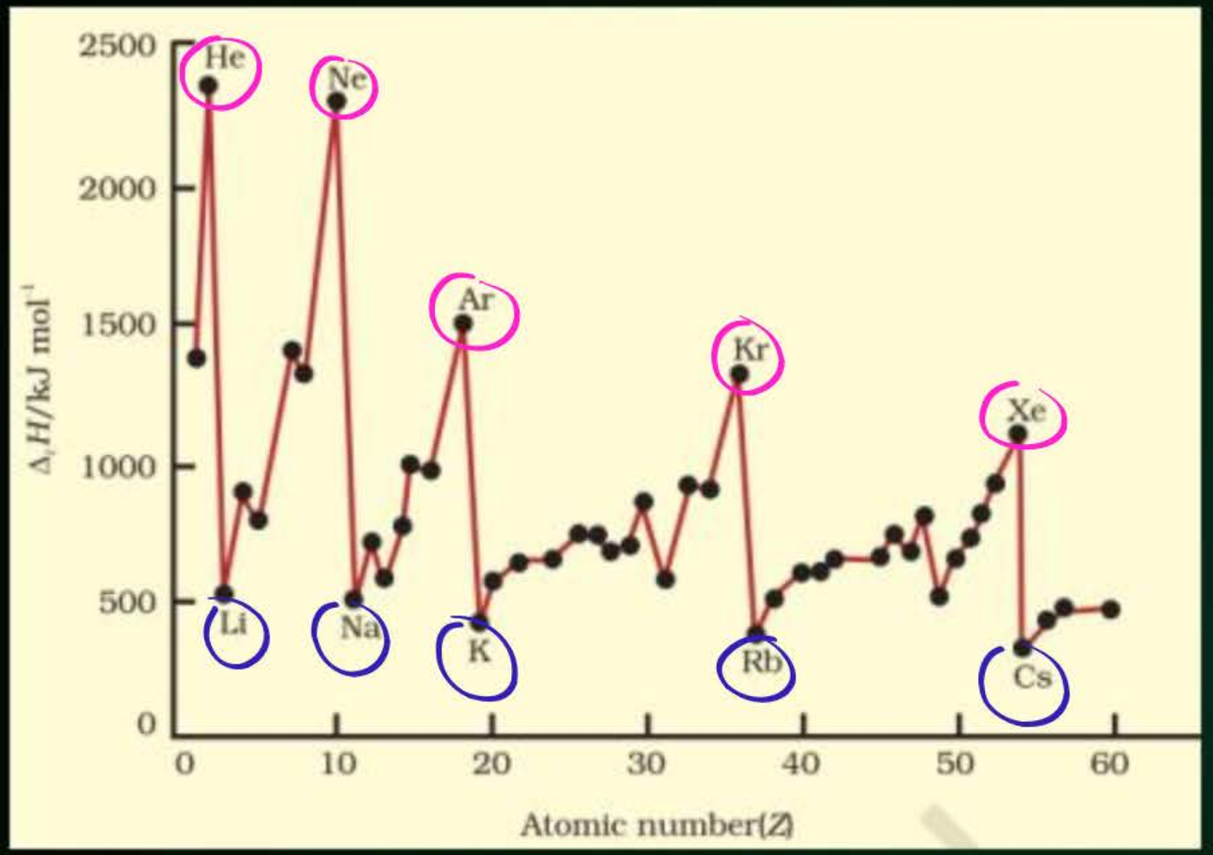
C $Na < Al < Mg < Si$

D $Na > Al > Mg > Si$

NCERT KI CHOTI CHOTI MAGAR MOTI BAATEIN

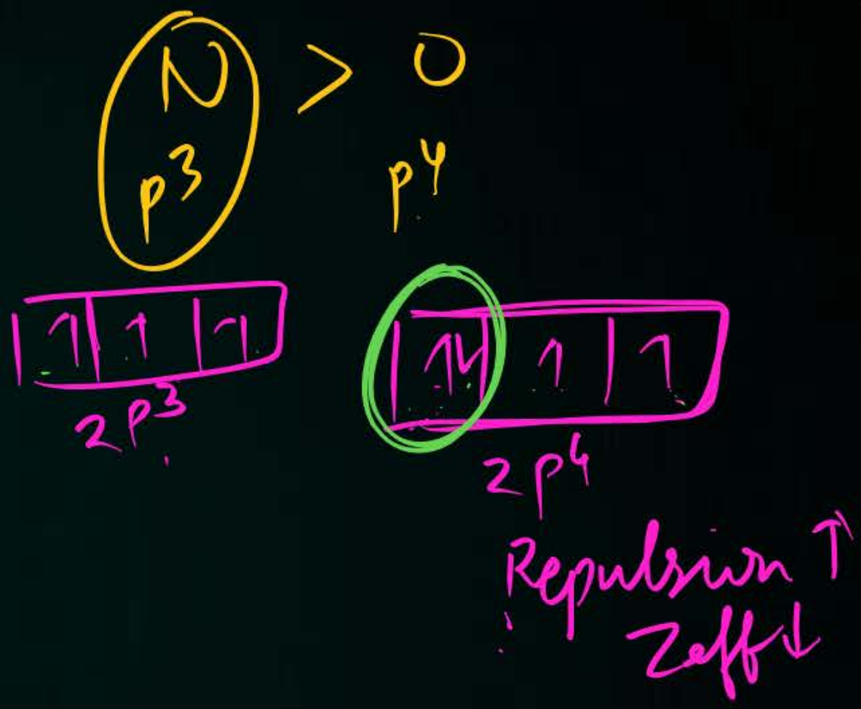

2500
2000
1500
1000
500
$\Delta_i H$/kJ mol^{-1}
0
2
4
6
8
10
Atomic number(Z)
Li
(520)
Be
(899)
B
(801)
C
(1086)
N
(1402)
O
(1314)
F
(1681)
Ne
(2080)





The periodicity of the graph is quite striking. You will find maxima at the noble gases which have closed electron shells and very stable electron configurations. On the other hand, minima occur at the alkali metals and their low ionization enthalpies can be correlated with their high reactivity.

The first ionization enthalpy of boron (Z = 5) is slightly less than that of beryllium (Z = 4) even though the former has a greater nuclear charge. When we consider the same principal quantum level, an s-electron is attracted to the nucleus more than a p-electron. In beryllium, the electron removed during the ionization is an s-electron whereas the electron removed during ionization of boron is a p-electron. The penetration of a 2s-electron to the nucleus is more than that of a 2p-electron; hence the 2p electron of boron is more shielded from the nucleus by the inner core of electrons than the 2s electrons of beryllium. Therefore, it is easier to remove the 2p-electron from boron compared to the removal of a 2s- electron from beryllium. Thus, boron has a smaller first ionization enthalpy than beryllium. Another "anomaly" is the smaller first ionization enthalpy of oxygen compared to nitrogen. This arises because in the nitrogen atom, three 2p-electrons reside in different atomic orbitals (Hund's rule) whereas in the oxygen atom, two of the four 2p electrons must occupy the same 2p-orbital resulting in an increased electron-electron repulsion. Consequently, it is easier to remove the fourth 2p-electron from oxygen than it is, to remove one of the three 2p-electrons from nitrogen.


N
p3
> 0
p4
2p3
2p4
Repulsion ↑
Zeff ↓

THANK YOU

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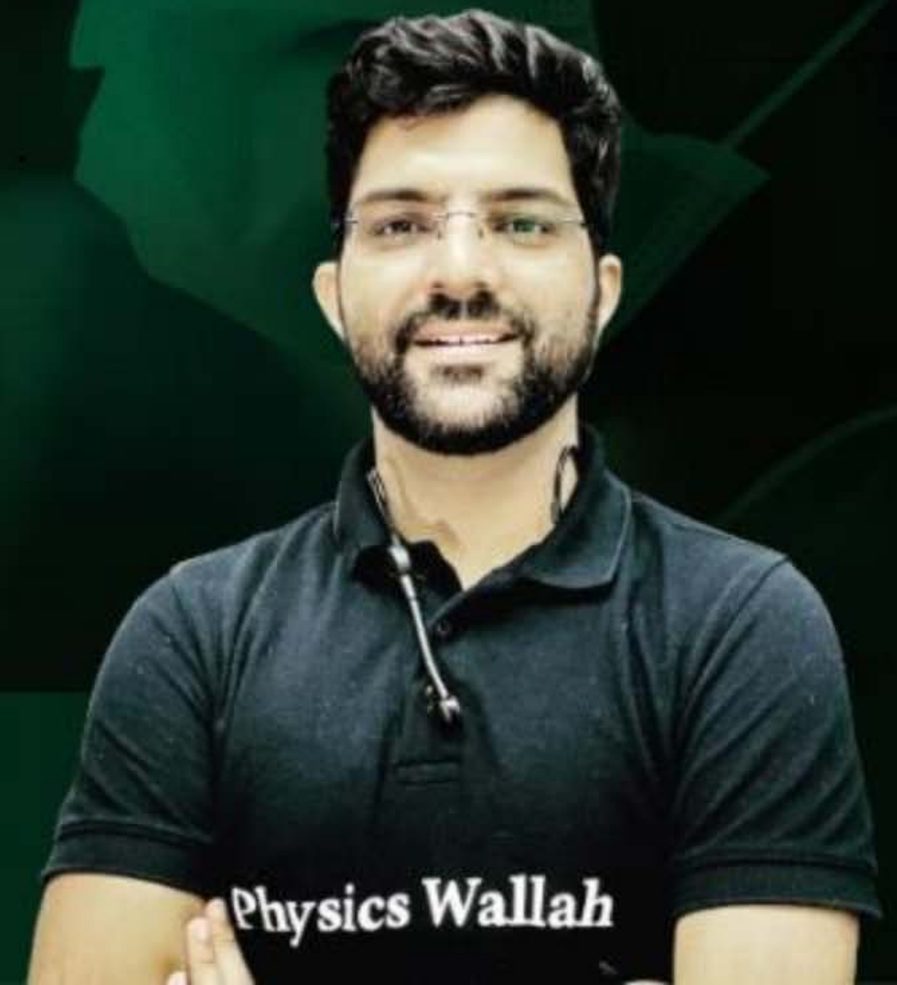
FOR NEET 2025

Lecture- 08 | Inorganic Chemistry

Classification of Elements and Periodicity in Properties

By - Mohit Dadheech (MD Sir)



Topics *to be covered*

1. Applications of I.E.
2. Blockwise Ionization Energy
3. Electrongain Enthalpy

Applications of I.E.

(1) Reactivity of Metals :-

I.E ↓ Reactivity ↑se

Electropositive

Tendency to loose e^-

Li
Na
K
Rb
Cs

n ↑ Size ↑
I.E ↓
Reactivity ↑se

Imp (2) Prediction of Valence e^- & Possible Oxidation state:-

(M)

$I.E_1$	$I.E_2$	$I.E_3$	$I.E_4$
50	78	325	415

Largest Jump Between $I.E_2$ & $I.E_3$

Valence shell $e^- \Rightarrow 2$

Possible O.S $\longrightarrow +2$ (M^{2+})

Formula of It's

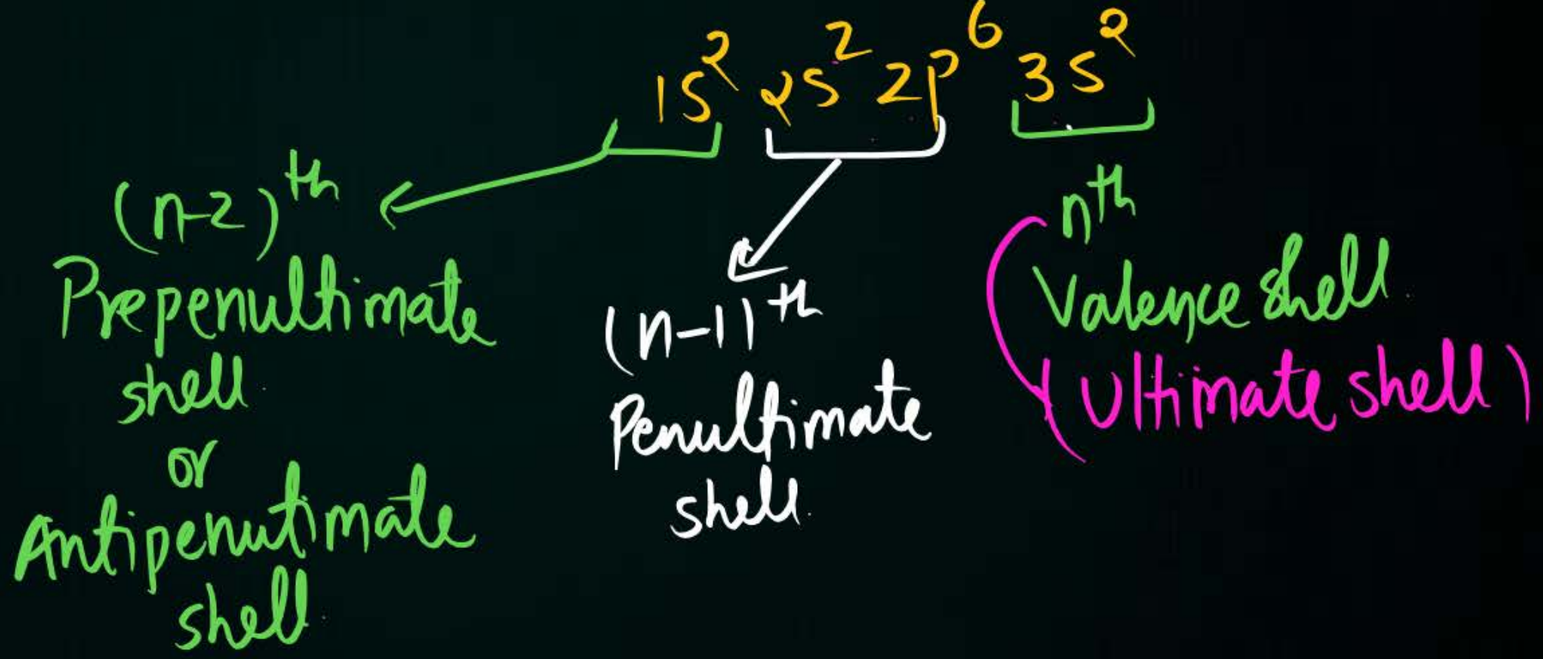
M^{2+}

Carbonate	CO_3^{2-}	M^{2+}	MCO_3
Nitride	N^{3-}	M^{2+}	M_3N_2
Nitrate	NO_3^-	M^{2+}	$M(NO_3)_2$
Oxide	O^{2-}	M^{2+}	MO
chloride	Cl^-	M^{2+}	MCl_2
Sulphite	SO_3^{2-}	M^{2+}	MSO_3
Sulphate	SO_4^{2-}	M^{2+}	MSO_4

Valence shell

↓

gen. Outer most shell



QUESTION

IE_1 IE_2 IE_3

Valence e^-

A sudden large jump between the values of 2nd and 3rd IP of an element would be associated with the electronic configuration :-

A $1s^2, 2s^2\ 2p^6, 3s^1$ Valence e^- = 1

B $1s^2, 2s^2\ 2p^6, 3s^2\ 3p^5$ (7)

C $1s^2, 2s^2\ 2p^6, 3s^2\ 3p^2$ (4)

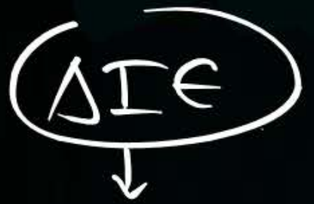
D $1s^2, 2s^2\ 2p^6\ 3s^2$ (2)

group No - (2)

Alkaline earth Metal.

Val e^- = 2

③ Stability of Oxidation states (Only for S-Block)
(Lower & Higher)



difference b/w two successive I.E

(1) if $\Delta IE \leq 11eV$ → Higher O.S will be stable

(2) If $\Delta IE \geq 16eV$ → Lower O.S will be stable

$Na \xrightarrow[10\ eV]{-e^-} Na^+ \xrightarrow[70\ eV]{-e^-} Na^{2+}$

$1s^2 2s^2 2p^6 3s^1$

IE_1 IE_2

Na^+ → $2p^6$

$\Delta IE = 60$

L.O.S will be stable

Na^+ ✓

Na^{2+} ✗✗

$Mg \xrightarrow[15eV]{IE_1} Mg^{+} \xrightarrow[22\ eV]{IE_2} Mg^{2+}$

$\Delta IE \leq 11eV$

$\Delta IE = 7eV$

H.O.S will be more stable

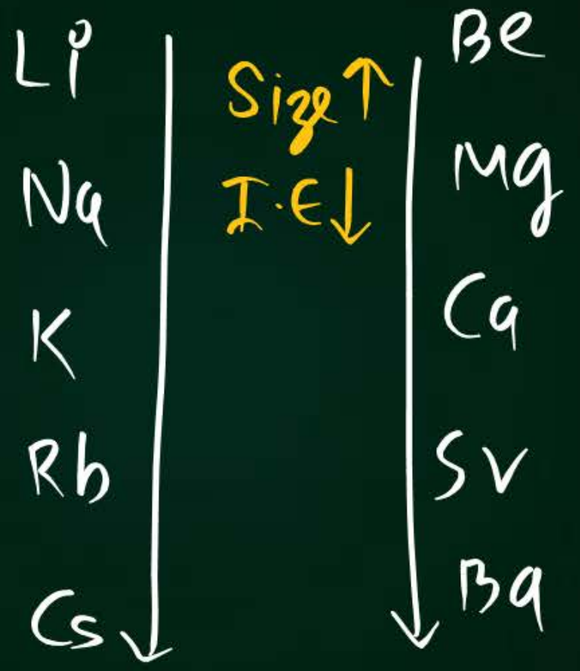
Mg^{+} ✗

Mg^{2+} ✓

Blockwise Ionization Energy

Top to bottom

S- Block



L→R

$I.E_1$ AM < AEM

$ns^1 < ns^2$

But $I.E_2$ AM > AEM

∵ because after removal of 1^{st} e^- AM achives Fully Filled stable Configuration

Ex $Na < Mg$ $(I.E_1)$

Na $1s^2 2s^2 2p^6 3s^1$ $\quad$ Mg $3s^2$

Na $1s^2 2s^2 2p^6 3s^1$ > Mg $3s^2$ $3s^1$

p-Block

Top → Bottom

Imp

13th — 14th — 15th — 18th

No exception → (T → B I.E ↓)

B
Al
Ga
In
Tl
(8)

C
Si
Ge
Sn
Pb
(8)

T.C
due to poor σ of 3d e⁻
Zeff ↑ so I.E ↑

due to poor σ of 4f e⁻ Zeff ↑ I.E ↑ (L.C)

Final orders

13th B > Tl > Ga > Al > In.

Beet Gai

14th C > Si > Ge > Pb > Sn

d-Block

(L→R) 3d series :-

Vinita thi Nahi Kon

Sc < V < Cr < Ti < Mn < Ni < Cu < Co < Fe < Zn

Suno Kamal Mani Kyu Fir Jane.

Imp Points

* I.E$_2$ of elements ↑se L→R (Generally)
* I.E$_1$ For First member of each series is min & Last member have max I.E.

3d Sc$_{min}$ - - - Zn max

4d Y$_{min}$ - - - Cd max

5d La$_{min}$ - - - Hg max

Imp. Orders

$Cr < Mn$ $(I.E_1)$

$Cr > Mn$ $(I.E_2)$

Cr: $3d^5 4s^1$ $\quad$ Mn: $3d^5 4s^2$

$3d^5$ $\quad$ $4s^1$

Half filled stable

$Cu < Zn$ $(I.E_1)$

$Cu > Zn$ $(I.E_2)$

Cu: $3d^{10} 4s^1$ $\quad$ Zn: $3d^{10} 4s^2$

$3d^{10}$ $\quad$ $4s^1$

Fully filled stable

QUESTION

* $I.E_2$ generally $L \to R$

The correct order of decreasing second ionization enthalpy of Ti(22), V(23), Cr(24) and Mn(25) is : [AIPMT 2008]

* $Cr > Mn$ ($I.E_2$)

A. Mn > Cr > Ti > V

B. Ti > V > Cr > Mn

C. Cr > Mn > V > Ti

D. V > Mn > Cr > T

$Mn < Fe \quad (IE_1)$

$Mn < Fe \quad (IE_2)$

$Mn > Fe \quad (IE_3)$

$3d^5 4s^2$ $\quad$ $3d^6 4s^2$

$3d^5$ $\quad$ $3d^6$

Half filled

QUESTION

Four successive members of the first row transition elements are listed below with their atomic numbers. Which one of them is expected to have the highest third ionization enthalpy :- [AIPMT 2005]

A Vanadium (Z = 23

B Manganese (Z = 25)

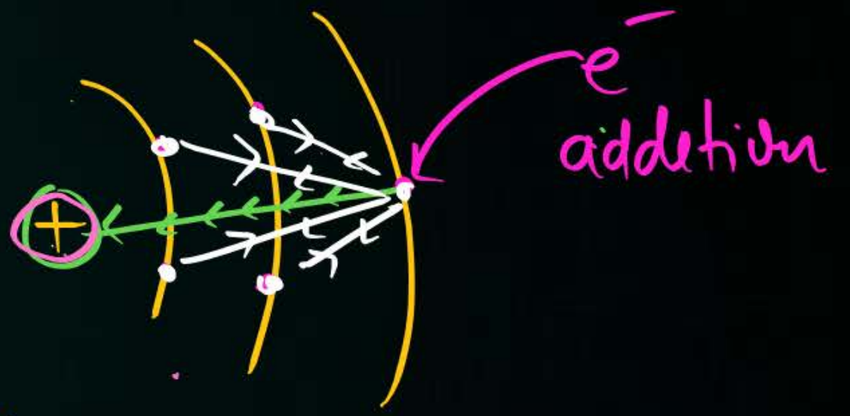
C Chromium (Z = 24)

D Iron (Z = 26)

Electron gain Enthalpy (ΔH_{eg})

* Addition of e^-

↳ Overall change in Energy during the addition of $\bar{e}$ into an isolated gaseous atom.



If R > A
then ΔH_{eg} +ve
Endothermic

Repulsion Energy ↑se
Attraction Energy ↓

If A > R ⇒ ΔH_{eg} -ve
Exo.

Relation b/w EA & ΔH_{eg}

EA
(Neeyat)

EA Positive

↓

ē ko bulane/Neeyat Jyada → ΔH_{eg} -ve Exothermic

EA Negative
EA Zero → ΔH_{eg} +ve Endothermic

ΔH_{eg} Electron gain Enthalpy
Energy Measurement

Electron Gain Enthalpy

When an electron is added to a neutral gaseous atom (X) to convert it into a negative ion, the enthalpy change accompanying the process is defined as the Electron Gain Enthalpy ($\Delta_{eg}H$).

Electron affinity (E.A) :
Tendency to gain electron.

→ ΔH_{eg} → Measurement of tendency in terms of Energy.

Electron gain enthalpy (ΔH_{eg}):

- Electron affinity is measured in terms of electron gain enthalpy.
- For neutral element ΔH_{eg} is exothermic **except N, Alkaline earth metals and inert gases.** (Be & Mg)
- ΔH_{eg} of cation is always exothermic.
- ΔH_{eg} of anion is always endothermic (formation of poly negative anions).

Exothermic/Endothermic Process :

* Addition of e^- in Cation → Always Exo.
* Addition of e^- in anion
  or
  Formation of Polynegative anion.

→ Always Endothermic.
∵ due to more Repulsion (Interelectronic Repulsion)

* Addition of e in N, Be, Mg and Inertgases → Endothermic

$Cl + e^- \longrightarrow Cl^-$ Exo

$F + e^- \longrightarrow F^-$ Exo

$N + e^- \longrightarrow N^-$ Endo

$Be + e^- \longrightarrow Be^-$ Endo

I.E $O \longrightarrow O^+ + e^-$ (Endo)

$O + 2e^- \longrightarrow O^{2-}$ (Endo)

$O^- + e^- \longrightarrow O^{2-}$ (Endo)

$S + 2e^- \longrightarrow S^{2-}$ (Endo)

$Na^+ + e^- \longrightarrow Na$ (Exo)

$Ne + e^- \longrightarrow Ne^-$ (Endo)

$Xe \longrightarrow Xe^+ + e^-$ (Endo)

Step-I $O + e^- \longrightarrow O^-$ (Exo) -150 ΔH_{eg} -ve

Step-II $O^- + e^- \longrightarrow O^{2-}$ (Endo) $+800$ ΔH_{eg} +ve.

$O + 2e^- \longrightarrow O^{2-}$ (Endo) $\rightarrow$ $+800 - 150$

$= +650$ Endo

Step-II $\rightarrow$ due to rise in Inter electronic repulsion

ΔH_{eg} +ve.

QUESTION

$O_{(g)} + 2e^- \rightarrow O^{2-}_{(g)}$ $\Delta H_{eg} = 744.7$ KJ/mole.

The positive value of ΔH_{eg} is due to :-

A. Energy is released to add on 1 e^- to O^{-1}

B. Energy is required to add on 1 e^- to O^{-1}

C. Energy is needed to add on $1e^-$ to O

D. None of the above is correct

QUESTION

Electron addition would be easier in :-

A O

B O^{+}

C O^{-}

D O^{+2}

QUESTION

The process requiring the absorption of energy is. (Endo)

A $F \rightarrow F^-$ ✗

B $Cl \rightarrow Cl^-$ ✗

C $O \rightarrow O^{2-}$ ✓

D $H \rightarrow H^-$ ✗

Homework

From Module

Questions based on Size & I.E

THANK YOU

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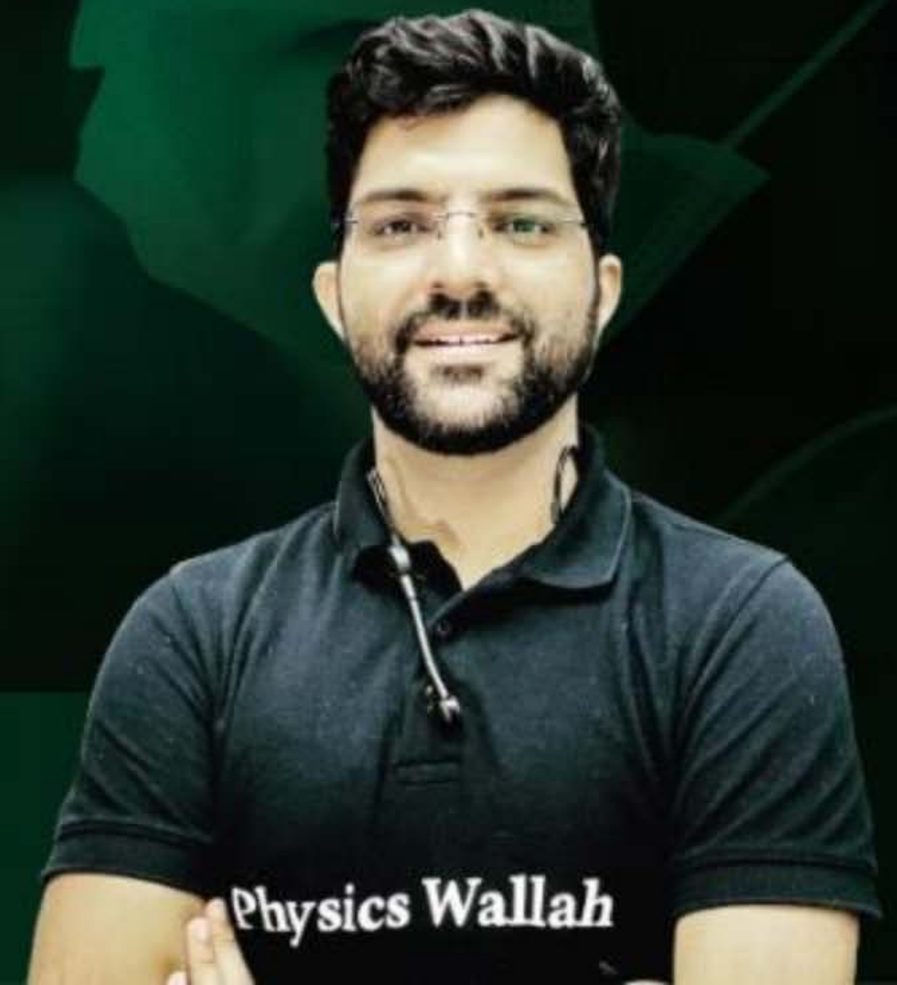
FOR NEET 2025

Lecture- 09 | Inorganic Chemistry

Classification of Elements and Periodicity in Properties

By - Mohit Dadheech (MD Sir)



Topics *to be covered*

1. Factors affecting EA & Imp Orders
2. Electronegativity (EN)
3.

Factors affecting EA :-

1. Size — Size ↓ EA ↑

2. Zeff — Zeff ↑ EA ↑

3. Stable Configuration
   - → Fully Filled np^6 — min EA in a period
   - → Half Filled
     - $np^2 > np^3$
     - $C > N$
     - Ex $2p^2$ $2p^3$
     - $3p^2$ $3p^3$
     - $Si > P$

4. Penetration Power → $ns^1 > np^1$
   - $Li > B$
   - $Na > Al$

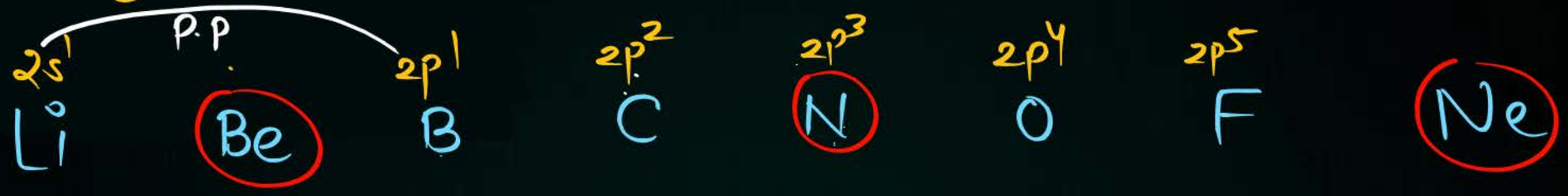
Zero EA or +ve Δ Heg

↑ Inert gas

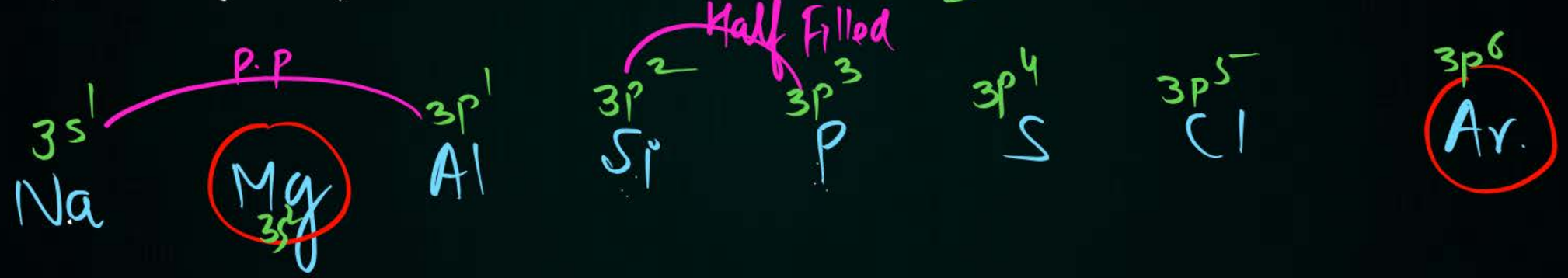
IE
- $np^3 > np^4$

P.P
- $ns^2 > np^1$

EA order of 2nd & 3rd Period :-



Ne < Be < N < B < Li < C < O < F



Ar < Mg < Al < Na < P < Si < S < Cl

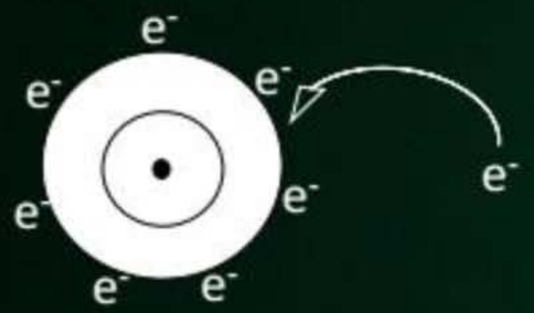
In Some p-Block Elements.

Why the EA of 3rd period elements is more than EA of 2nd period elements ?

F

[He] $2s^2 2p^5$

2nd Period

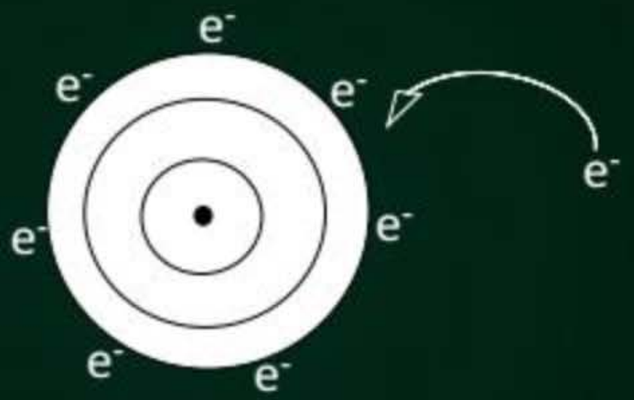


- Small size
- High surface e^- density
- More repulsion for upcoming e^-
- Less attraction for new e^-
- Less EA (Less –ve value of $\Delta_{eg}H$)

Cl

[Ne] $3s^2 3p^5$

3rd Period



- Large size
- Low surface e^- density
- Less repulsion for upcoming e^-
- More attraction for new e^-
- More EA (More –ve value of $\Delta_{eg}H$)

2nd Period	B	C	N	O	F
3rd Period	Al	Si	P	S	Cl

(Same reason)

Imp orders :-

Halogen Family: F < Cl > Br > I

Cl > F > Br > I

Oxygen Family: O < S > Se > Te > Po

S > Se > Te > Po > O

Most Imp For NEET

Halogen has max $\in A$ in a period.

Max $\in A$ in PT $\Rightarrow$ Cl

QUESTION

Arrange the following in increasing order of electron affinity :

O, S, F, Cl

O < S < F < Cl Imp PYQ

Na, Si, P, S

Na (s^1) Si (p^2) P (p^3) S (p^4) ⇒ Na < P < Si < S

F, Cl, Br, I

I < Br < F < Cl

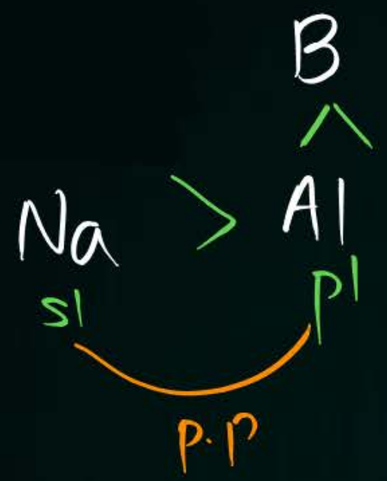
Li, Be, B, C

Li (s^1) Be (s^2) B (p^1) C (p^2)

p·p

Be < B < Li < C

Na B Al



B < Al < Na

QUESTION

For electron affinity of halogens which of the following is correct :

A. Br > F ✗

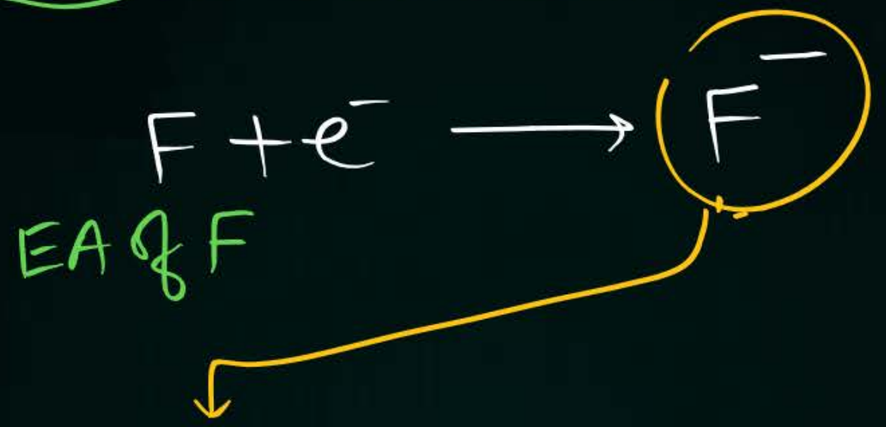
B. F > Cl ✗

C. Br > Cl ✗

D. F > I ✓

Cl > F > Br > I

Relation b/w I.E & E.A :-



$$|E.A \text{ of } F| = |I.E \text{ of } F^-|$$

① $|EA| = |I \cdot E|^{-1}$ (T)

② $|EA| = |I \cdot E|$ (F)

③ $|EA|^{T} = |I \cdot E|$ (T)

QUESTION

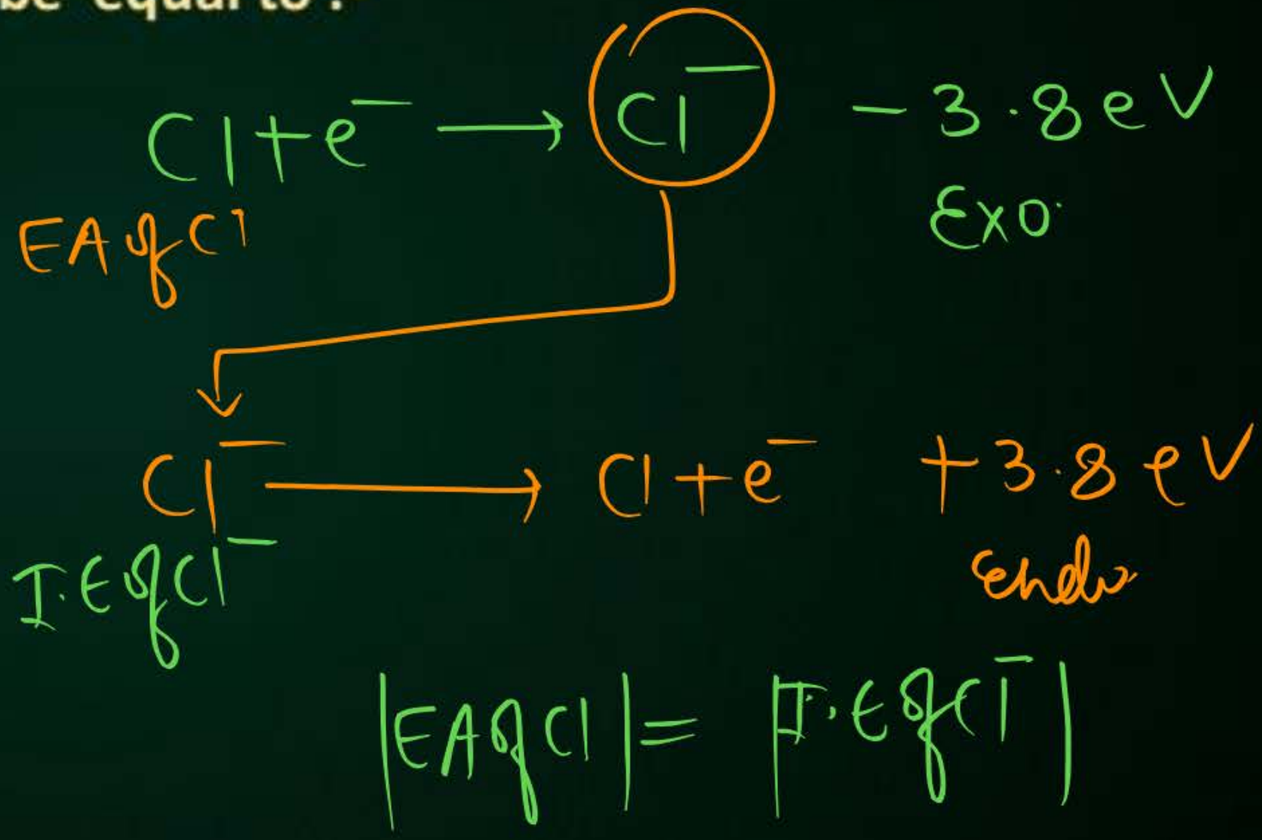
In the formation of a chloride ion, from an isolated gaseous chlorine atom, 3.8 eV energy is released, which would be equal to :-

A Electron affinity of Cl^-

B Ionisation potential of Cl

C Electronegativity of Cl

D Ionisation potential of Cl^-



QUESTION

Process $Na^+ \xrightarrow{I} Na_{(g)} \xrightarrow{II} Na_{(s)}$

$Na^+ + e^- \longrightarrow Na_{(g)}$ (Exo)

$Na_{(g)} \downarrow$

$Na_{(s)}$ (Exo)

A. In (I) energy released, (II) energy absorbed

B. In both (I) and (II) energy is absorbed

C. In both (I) and (II) energy is released ✓

D. In (I) energy absorbed, (II) energy released

QUESTION

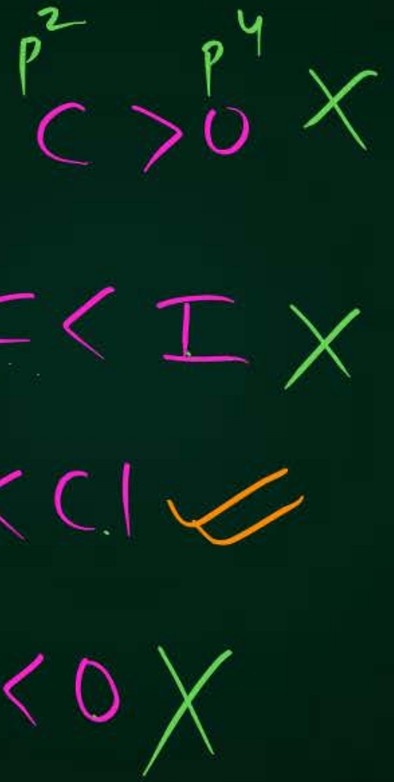
The electron affinity

A. Of carbon is greater than oxygen

B. Of fluorine is less than iodine

C. Of F is less than Cl

D. Of S is less than oxygen



QUESTION

Which of the following electronic configuration is expected to have highest electron affinity:-

A $2s^2\ 2p^0$

B $2s^2\ 2p^2$

C $2s^2\ 2p^3$

D $2s^2\ 2p^1$

THANK YOU

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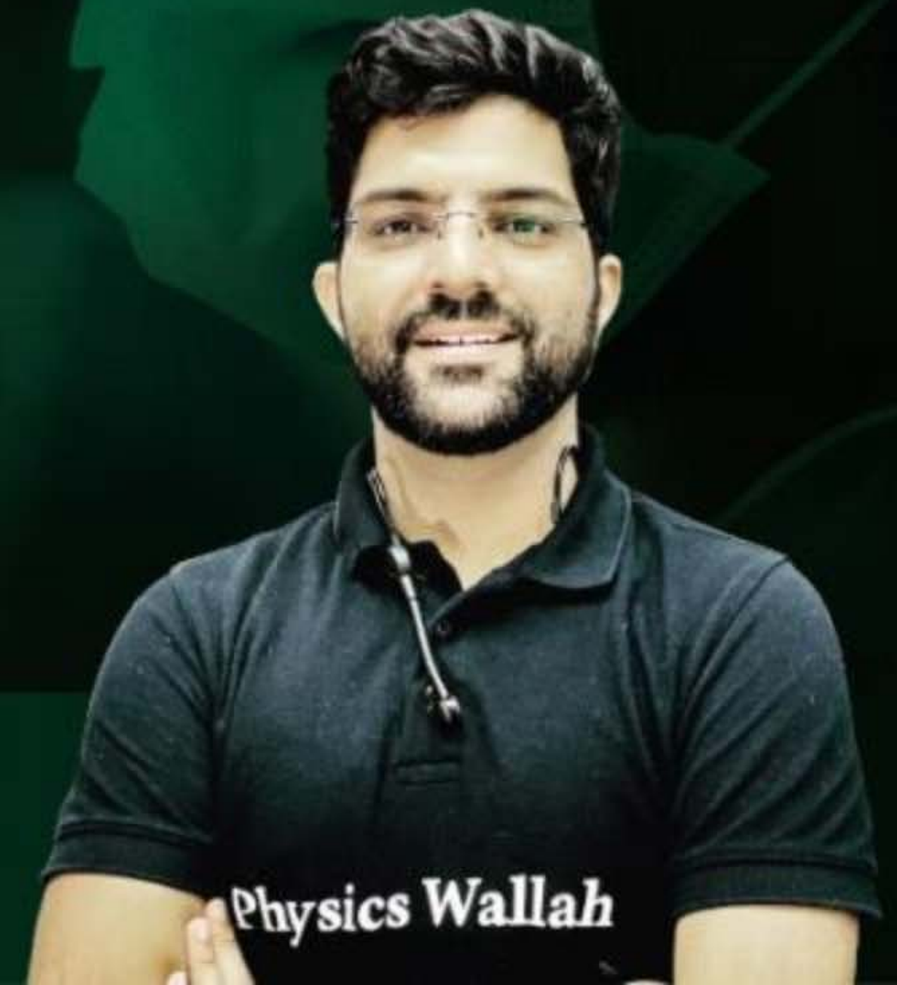
FOR NEET 2025

Lecture - 10 | Inorganic Chemistry

Classification of Elements
and
Periodicity in Properties

By - Mohit Dadheech (MD Sir)



Topics *to be covered*

1. Electronegativity (Part-02)

(2) Development of Periodic Table (History)

QUESTION

For electron gain enthalpies of the elements denoted as $\Delta_{eg}H$, the incorrect option is:

A $\Delta_{eg}H(Te) < \Delta_{eg}H(Po)$ ✓

B $\Delta_{eg}H(Se) < \Delta_{eg}H(S)$ ✗

C $\Delta_{eg}H(Cl) < \Delta_{eg}H(F)$ ✓

D $\Delta_{eg}H(I) < \Delta_{eg}H(At)$ ✓

−320 −180 Large

Cl > F > Br > I > At

−350 −200 −100

ΔH_{eg}

S > Se > Te > Po > O

−300 −200 −150 −100 −50

Low EA

JEE Mains

−150 → Small Value

ΔH_{eg}

High EA

Q Compare electron gain enthalpy in Halogens (with negative sign)

$F < Cl > Br > I$

$Cl > F > Br > I$

$-350 \quad -320 \quad -200 \quad -180$

EA

QUESTION

(Inertgas, N, Be, Mg)

Inert gases have positive electron gain enthalpy. Its correct order is

A. He < Xe < Kr < Ne

B. He < Ne < Kr < Xe

C. Xe < Kr < Ne < He

D. He < Kr < Xe < Ne

According to NCERT Data

* He +48
* Ne +116
Ar +96
Kr +96
Xe +77
Rn +68

Electronegativity :

* Unitless quantity

(Covalent Bond)

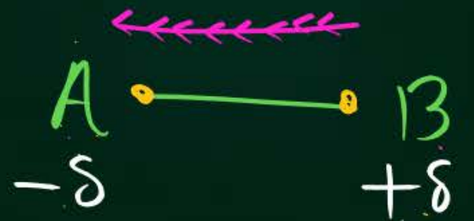
"The tendency of an atom to attract the shared pair of electrons towards it self

- It does not depend on electronic configuration

If $\Delta EN > 1.7$] Ionic Bond.

If $\Delta EN \simeq 0.4$ to 1.7 Polar Covalent Bond

If $\Delta EN < 0.4$ Non polar covalent



If $EN_A > EN_B$

$\Delta EN \uparrow$

→ Bond polarity ↑se

→ % Ionic character ↑se.

Factors affecting EN :

- Size $\quad Size \propto \frac{1}{EN}$
- Z Effective $\quad Z_{eff} \propto EN$
- Oxidation state $\quad M^- \; M^0 \; M^+ \; M^{2+}$ → (O.S ↑ Z_{eff} ↑ EN ↑)
- % s character in Hybrid orbitals :-

	sp	sp^2	sp^3
% s	50	33	25
% p	50	66	75

% s ↑ EN ↑

$sp > sp^2 > sp^3$

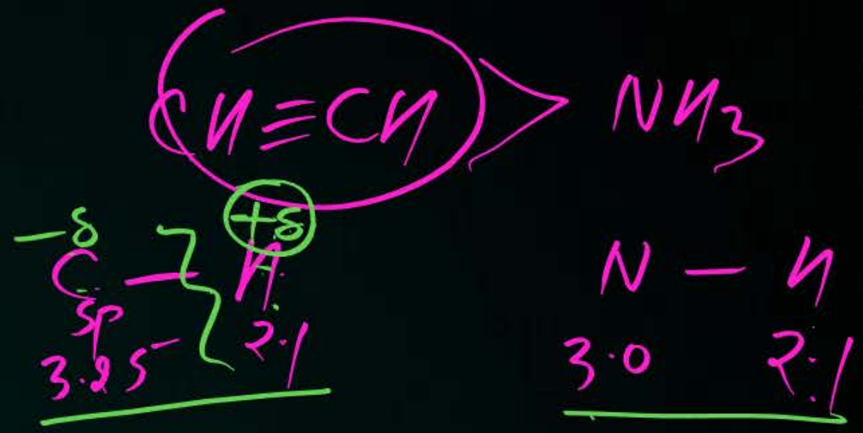
{Same Element can show diff EN values in diff O.S & Hybrid state.

$\overset{-3}{N}H_3 < \overset{+4}{N}O_2$ (EN of N)

Ex

$\overset{+3}{P}Cl_3 < \overset{+5}{P}Cl_5$ (EN)

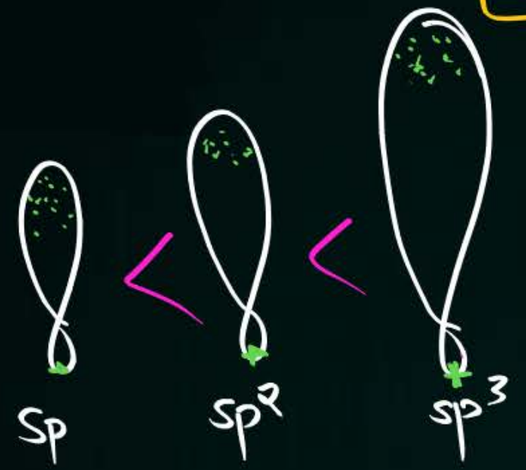
Ex	C_{sp}	C_{sp^2}	C_{sp^3}
	3.25	2.75	2.50


H≡CH
NH3
−δ
+δ
C
H
sp
3.25
2.1
N — H
3.0
2.1

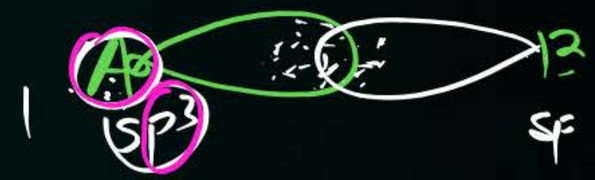
Size of Hybrid orbital

Shape → same !

Size



% p ↑se → Length of Hybrid orbital ↑se



Application of EN :

(1) Non metallic character

EN ↑ NMC ↑

(Ex) F Cl Br I

Size ↑, EN ↓, NMC ↓, Reactivity ↓

Reactivity of N.M ∝ EN

(2) Inter nuclear distance $d_{A-B} = r_A + r_B - 0.09 (X_A - X_B)$

or ΔEN

(3) % Ionic Character = $16 (\Delta EN) + 3.5 (\Delta EN)^2$

(4) Acidic/Basic/Amphoteric nature of oxides and hydroxides.

Q If $d_{A-A} = 1.00$, $d_{B-B} = 1.54$
& EN of A & B is 4.0 & 3.0 respectively. $\Big\}$ $\Delta EN = 4-3 = 1$
then find d_{A-B}.

$$r_A = \frac{d_{A-A}}{2} = \frac{1.00}{2} = 0.50$$

$$r_B = \frac{d_{B-B}}{2} = \frac{1.54}{2} = 0.77$$

$$d_{A-B} = r_A + r_B - 0.09(\Delta EN)$$

$$= 0.50 + 0.77 - 0.09(1)$$

Ans =

Find % Ionic Character in HF

given - EN of F = 4.0

EN of H = 2.1

ΔEN 4.0 − 2.1

1.9

$$\%IC = 16\,\Delta EN + 3.5\,(\Delta EN)^2$$

$$= 16 \times 1.9 + 3.5\,(1.9)^2$$

$\%IC =$

Different scales of EN :

- **Pauling scale** - Based on bond energy

H 2.1						
Li 1.0	Be 1.5	B 2.0	C 2.5	N 3.0	O 3.5	F 4.0
Na 0.9	Mg 1.2	Al 1.5	Si 1.8	P 2.1	S 2.5	Cl 3.0
K 0.8						Br 2.8
Rb 0.8						I 2.5
Cs 0.7						
Fr 0.7						

- **Mulikan scale** - Based on IP and EA

$$EN_{M.S} = \frac{IP+EA}{2}$$

$$EN_{P.S} = \frac{EN_{M.S}}{2.8}$$

$$EN_{M.S} = 2.8 \times EN_{2.8}$$

QUESTION

Electronegativity of the following elements increases in the order.

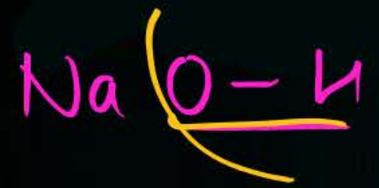
A O, N, S, P

B P, S, N, O

C P, N, S, O

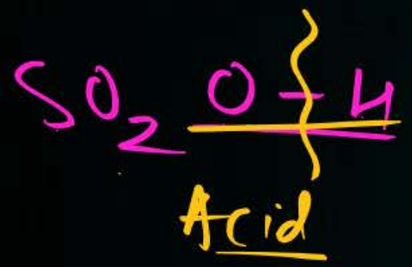
D S, P, N, O

Acidic/Basic Nature of O^{2-}/OH



NaOH
Base

Na_2O
Basic

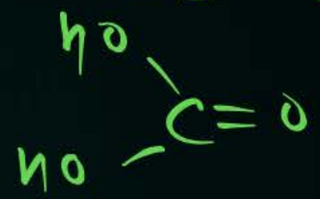


$Ca(OH)_2$
Base

CaO
Basic.

$SO_2(OH)_2$
Acidic
or
H_2SO_4

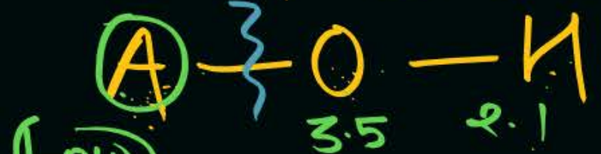
SO_3
Acidic.



$H_2CO_3 \rightarrow CO_2$
Acidic.

$CO(OH)_2$
Acidic

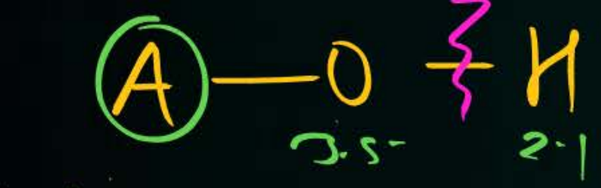
ΔEN_1 ΔEN_2



Low EN

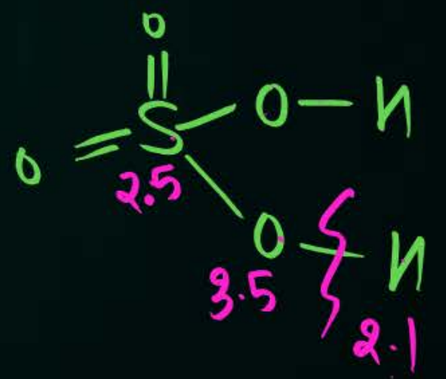
$$A{-}O{-}H \longrightarrow A^{+} + OH^{-}$$ Base

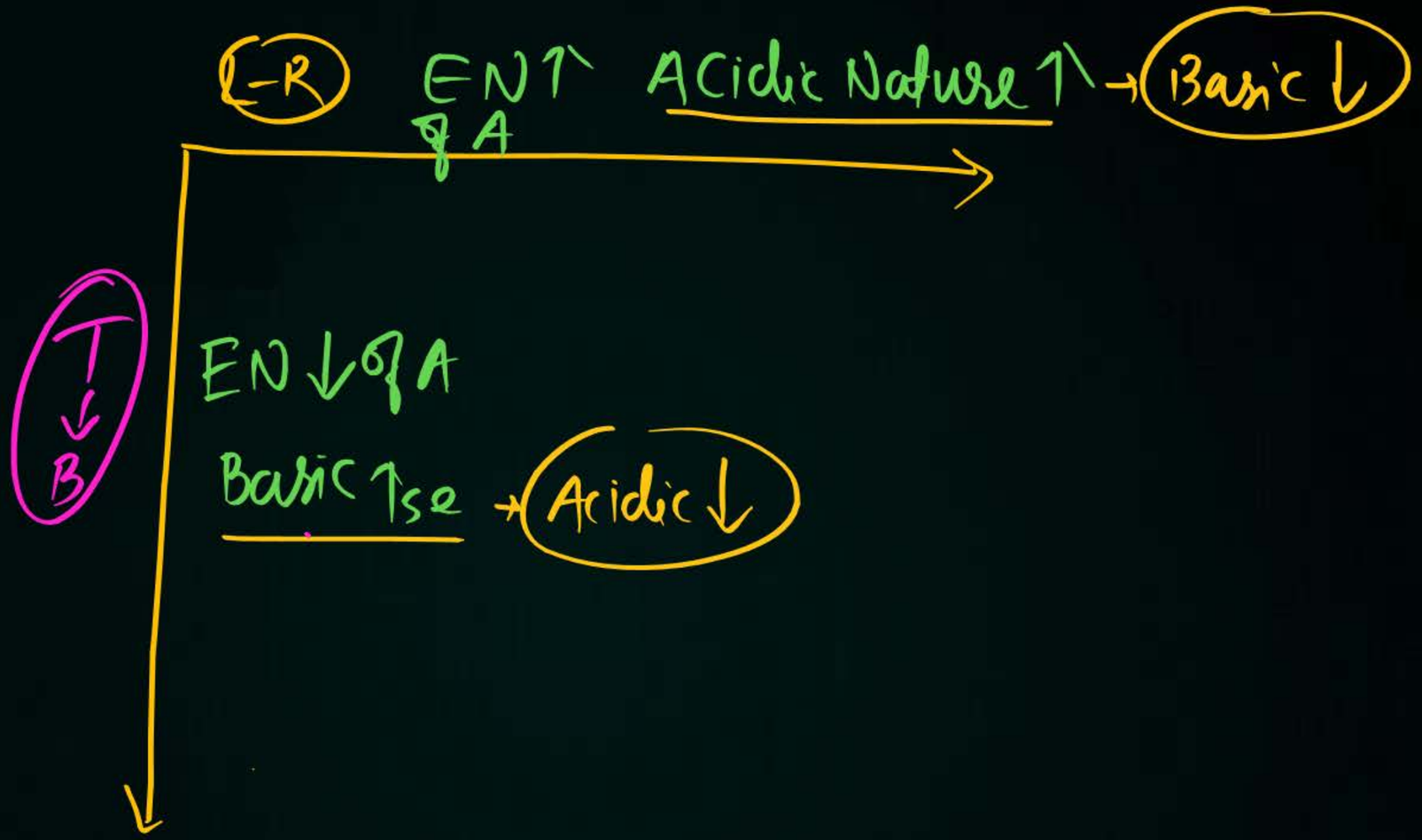
Na	O	H
0.9	3.5	2.1



$$A{-}O{-}H \longrightarrow AO^{-} + H^{+}$$ Acid

High EN




(-R)
EN↑
of A
ACidic Nature ↑
Basic ↓
T ↓
B
EN ↓ of A
Basic ↑ se
Acidic ↓

QUESTION

Compare Acidic/Basic nature in following

$NaOH > Mg(OH)_2 > Al(OH)_3 > Si(OH)_4$ (Basic)

$Li_2O < Na_2O < K_2O$ (Basic)

$Li_2O < BeO < B_2O_3$ (acidic)

$P_4O_{10} < SO_3 < Cl_2O_7$ (acidic)

$MnO > Mn_2O_3 > Mn_2O_7$ (Basic)

+2 +3 +7

O.S ↑ EN ↑ A ↑ B ↓

+3 +5

$HNO_2 < HNO_3$ (acidic)

$HClO_2 < HClO_3 < HClO_4$ (acidic)

+3 +5 +7

Some Imp. Points

(1) gen Metal oxides are Basic in nature
↳ Low EN → Basic

(2) gen Non Metal oxides are acidic in Nature
↳ High EN → Acidic

(3) Amphoteric O^{2-}/OH^-

Can act as acidic as well Basic

Zn Al Sb As Pb Be Sn Ga Cr^{3+}

Zn Janabe Al Sabse Sb Achha As Pb Punjabi Be Sn Song Ga Gayg Cr^{3+} Kero

(4) Some Neutral oxides

H_2O, NO, N_2O, CO

QUESTION

Which of the following oxides is amphoteric in nature ?

A CaO

B CO_2

C SiO_2

D SnO_2

Genesis of periodic classification (Development of periodic table) :

(i) Dobereiner Triads

- Li, Na, K is dobernier triads because atomic wt. of Na is equal to average atomic wt. of Li & K.

Jugad : Same group
ΔZ same

$8[{}_{3}Li \quad {}_{11}Na \quad {}_{19}K$ ✓✓

$8[{}_{4}Be \quad {}_{12}Mg \quad {}_{20}Ca$ ✓✓

$8[{}_{9}F \quad {}_{17}Cl \quad {}_{35}Br$ XX

$18[{}_{17}Cl \quad {}_{35}Br \quad {}_{53}I$ ✓✓

$18[{}_{18} \quad {}_{19} \quad {}_{35}Br$ XX

Fe, Co, Ni — same period

(ii) De chancourtois

- 3D model & DNA Helix like structure.

(iii) **Newlands octave rule**

sa	re	ga	ma	pa	dha	ni
Li	Be	B	C	N	O	F
sa						
Na						

Jugad : Same group

$\Delta Z = 8$

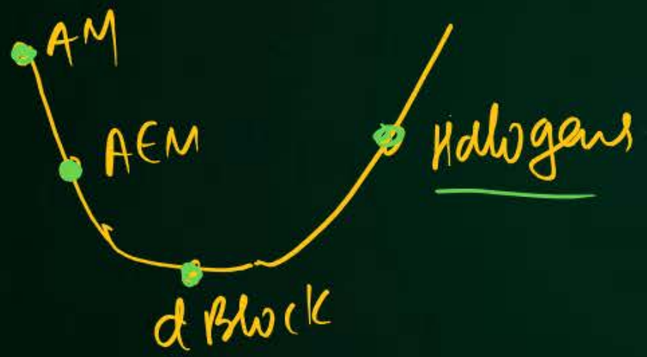
Disadvantage :

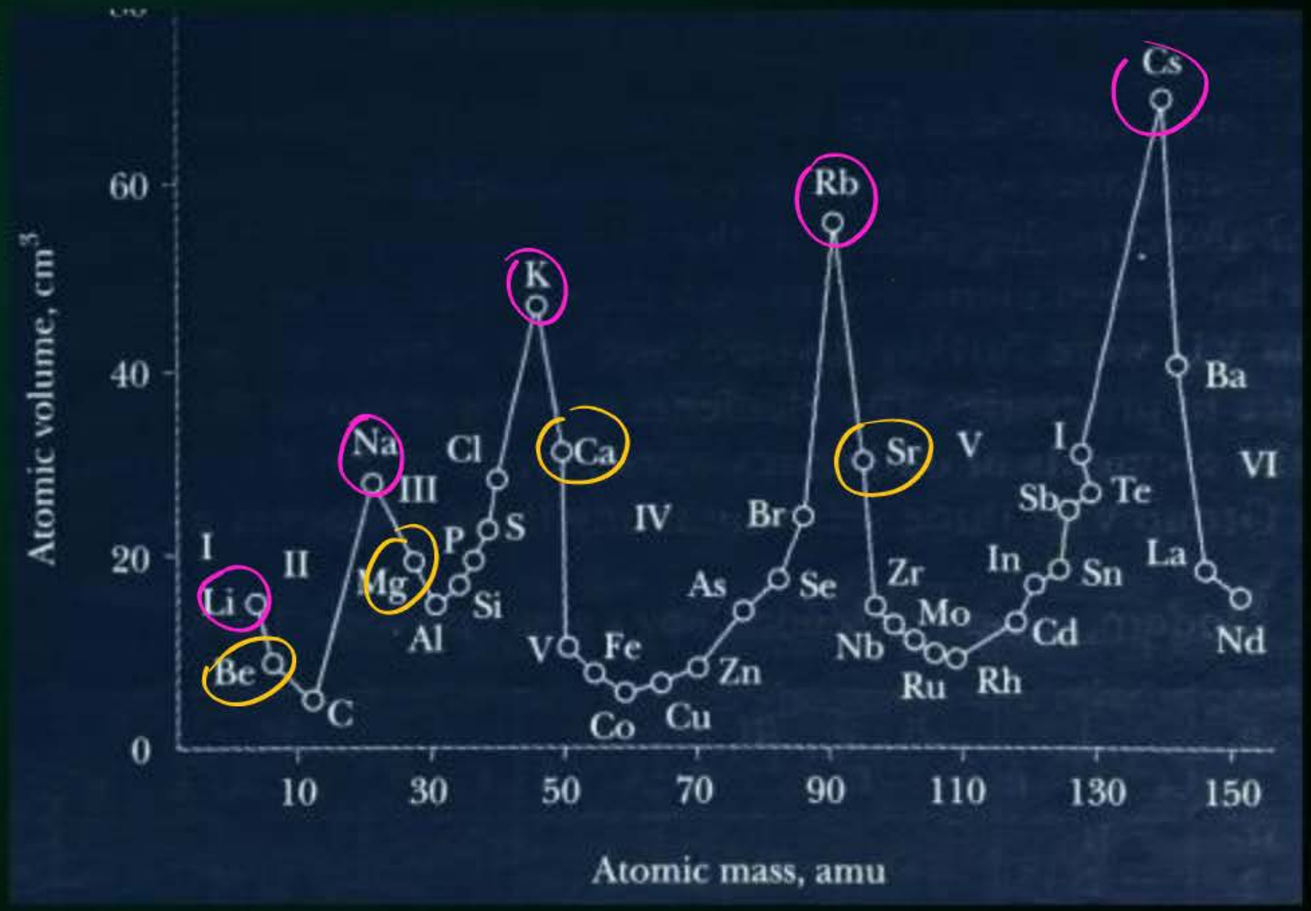
- Newlands's Law of Octaves seemed to be true only for elements up to calcium.
- after discovery of Inert gases this is Completely failed

(iv) Lothar Meyer curve

- Plotted Graph atomic mass *vs* atomic volume.

Peak position-Alkali metals ✓
Descending-alkaline earth metals
Ascending – Halogens
Bottom part – d-block elements





(v) Mendeleev's periodic table

"The properties of the elements are a periodic function of their atomic weights".

- **Advantages :**

(a) Discovery of new elements

Al	B	Si	Mn
|	|	|	|
Ga	Sc	Ge	Tc
[Eka aluminum]	[Eka Boron]	[Eka Silicon]	[Eka manganese]

ganga se Jamuna Tak

(b) Correction in Atomic weight of some element

Au	In	Pt	Be	U
Gold	In	Platinum	becomes	Utimate

- **Disadvantage :**
  Some element do not follows trend of increasing atomic weight.

Ar	–	K
Amir.		Khan
Te	–	I
Teri		Ichha.
Th	–	Pa
Thanda		Pani
Co	–	Ni
Kyo		Nahi

Anomalous Pair

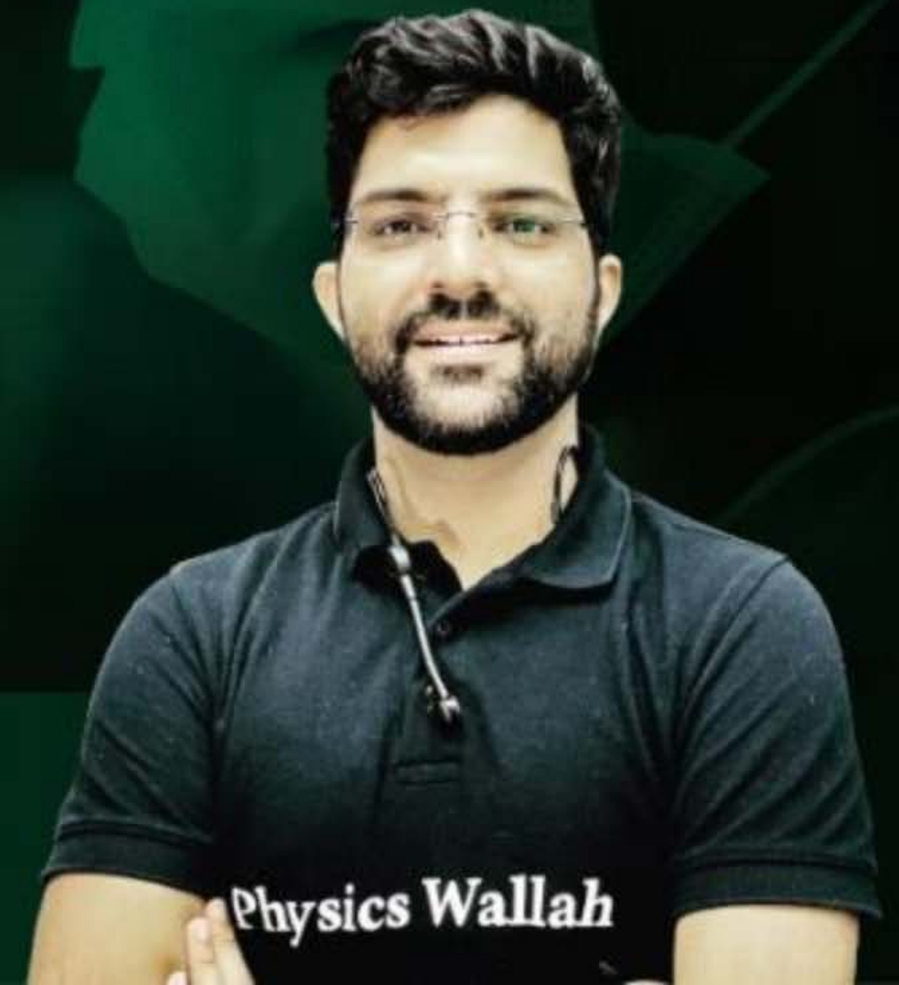
THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture - 11 | Inorganic Chemistry

Classification of Elements and Periodicity in Properties



By - Mohit Dadheech (MD Sir)

Topics *to be covered*

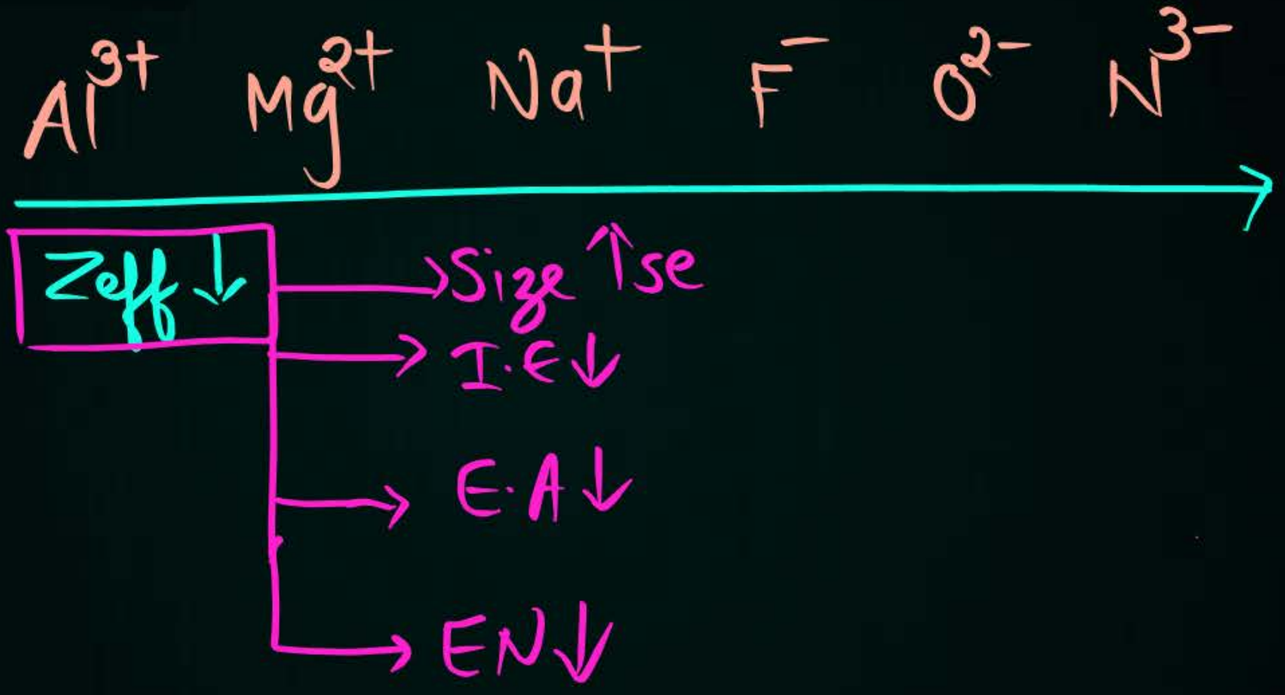
1. Some important points
2. NCERT Lines
3. Questions Practice

Some important points

1. Properties in isoelectronic series & ions of same element.
2. Ionization energy : f block
3. Diagonal relationship

Trend of Various properties in Isoelectronic Series

$Z_{eff} \propto \frac{+ve}{-ve}$



Trend of Various properties in ions of same element

Ionisation Energy (f-Block) (Lanthanoids)

Some imp points :- (NCERT 12th d & f Block)

* IE_1 (600) & IE_2 (1200) of lanthanoids are similar to Calcium

* IE_3 of La Gd Lu is abnormally low as compare to other elements

Reason:- All these three element will achive stable configuration after removal of 3rd e^-

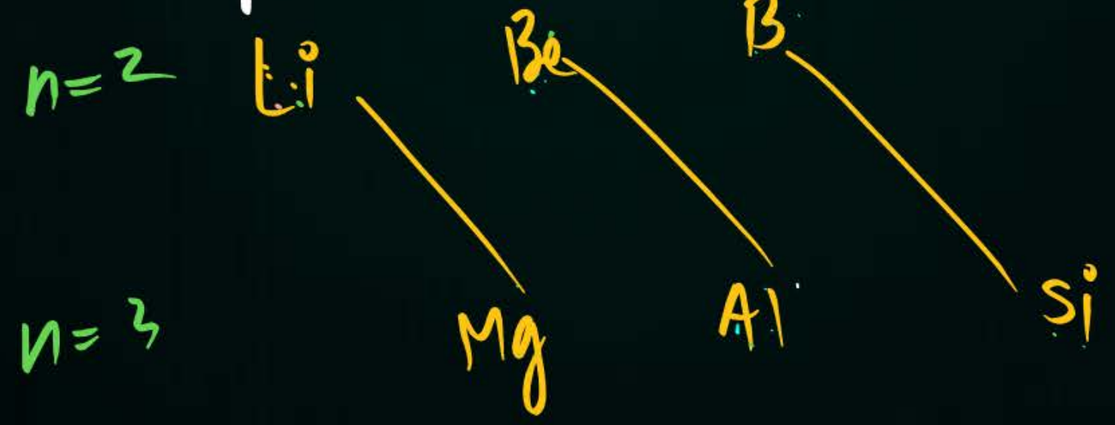
La $[Xe]\ 5d^1 6s^2$ will achive inert gas

Gd $[Xe]\ 4f^7 5d^1 6s^2$ will achive Half filled

Lu $[Xe]\ 4f^{14} 5d^1 6s^2$ will achive full filled

Diagonal Relationship :-

A phenomenon in which certain pairs of elements diagonally adjacent to each other in 2nd & 3rd Periods having similar properties



Reason of diagonal Relationship

(Ionic Potential)

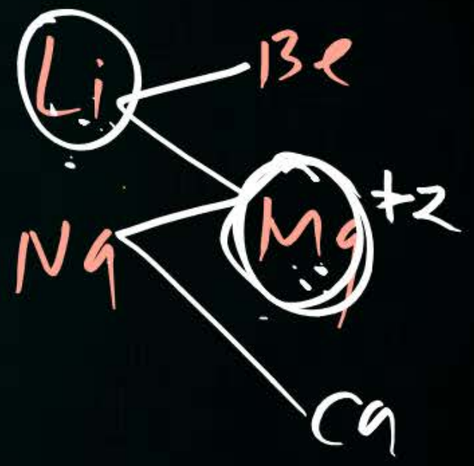
(i) Similar polarising power

Polarising Power $\propto$ $\frac{\text{Charge}}{\text{Radius}}$

ϕ

$Li^+ \simeq Mg^{2+}$

$\phi \propto \frac{q}{r}$

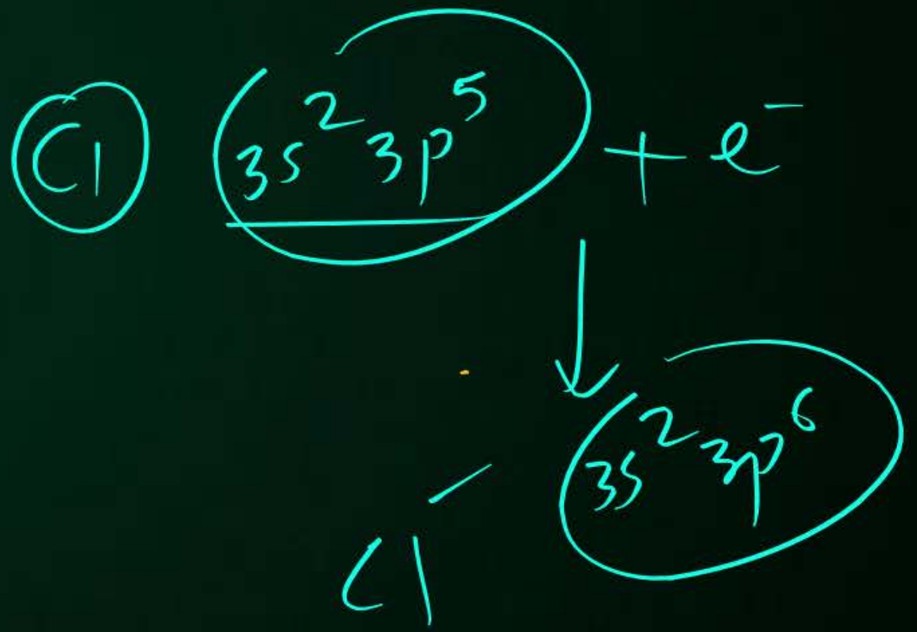


NCERT KI CHOTI CHOTI MAGAR MOTI BAATEIN

EA

EA

Depending on the element, the process of adding an electron to the atom can be either endothermic or exothermic. For many elements energy is released when an electron is added to the atom and the electron gain enthalpy is negative. For example, group 17 elements (the halogens) have very high negative electron gain enthalpies because they can attain stable noble gas electronic configurations by picking up an electron.



On the other hand, noble gases have large positive electron gain enthalpies because the electron has to enter the next higher principal quantum level leading to a very unstable electronic configuration. It may be noted that electron gain enthalpies have large negative values toward the upper right of the periodic table preceding the noble gases.

before

Halogen

F Ne

(n)

(Ne) $1s^2 2s^2 2p^6 + e^-$

$1s^2 2s^2 2p^6 | 3s |$

The variation in electron gain enthalpies of elements is less systematic than for ionization enthalpies. As a general rule, electron gain enthalpy becomes more negative with increase in the atomic number across a period. The effective nuclear charge increases from left to right across a period and consequently it will be easier to add an electron to a smaller atom since the added electron on an average would be closer to the positively charged nucleus. We should also expect electron gain enthalpy to become less negative as we go down a group because the size of the atom increases and the added electron would be farther from the nucleus.

Electron gain enthalpy of O or F is less negative than that of the succeeding element. This is because when an electron is added to O or F, the added electron goes to the smaller n = 2 quantum level and suffers significant repulsion from the other electrons present in this level. For the n = 3 quantum level (S or Cl), the added electron occupies a larger region of space and the electron-electron repulsion is much less.

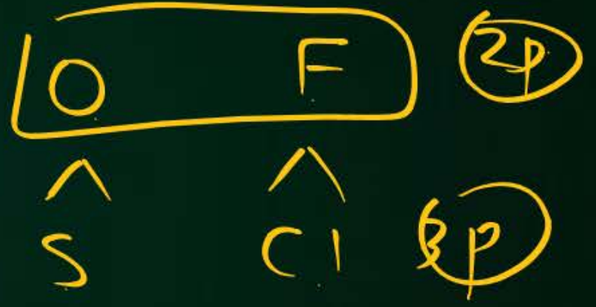


Table 3.7 Electron Gain Enthalpies* / (kJ mol^{-1}) of Some Main Group Elements

Group 1	$\Delta_{eg}H$	Group 16	$\Delta_{eg}H$	Group 17	$\Delta_{eg}H$	Group 0	$\Delta_{eg}H$
H	– 73					**He**	+ 48
Li	– 60	**O**	– 141	**F**	– 328	**Ne**	+ 116
Na	– 53	**S**	– 200	**Cl**	– 349	**Ar**	+ 96
K	– 48	**Se**	– 195	**Br**	– 325	**Kr**	+ 96
Rb	– 47	**Te**	– 190	**I**	– 295	**Xe**	+ 77
Cs	– 46	**Po**	– 174	**At**	– 270	**Rn**	+ 68

Valence shell :- gen. outer most shell

$1s^2 2s^2 2p^6 \underbrace{3s^2}$

Valence shell = 3
Valence e^- = 2 (0s +2)

In Many Cases

0.s is similar to Valence e^-

The valence is the most characteristic property of the elements and can be understood in terms of their electronic configurations. The valence of representative elements is usually (though not necessarily) equal to the number of electrons in the outermost orbitals and/or equal to eight minus the number of outermost electrons as shown below.

→ S & P Block Elements (According to NCERT)

ns^1 ns^2 ns^2np^1 ns^2np^2 ns^2np^3 ns^2np^4 ns^2np^5 ns^2np^6

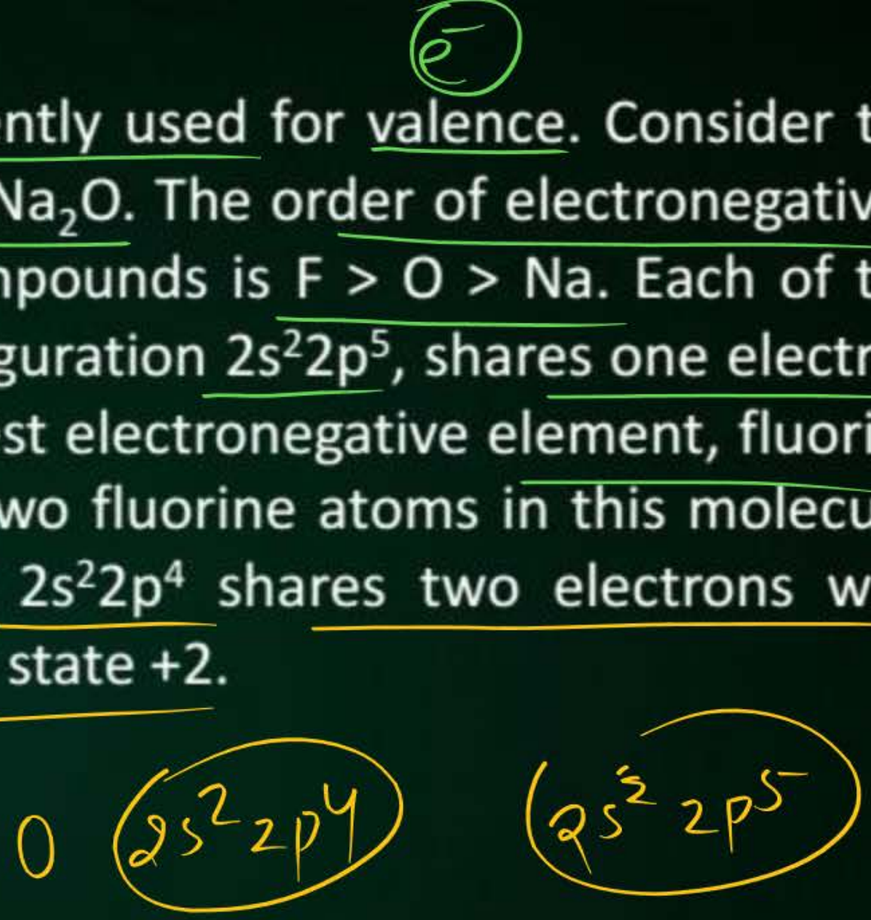
Group	1	2	13	14	15	16	17	18
Number of valence electron	1	2	3	4	5	6	7	8
Valence e^- / O.S	1	2	3	4	3,5	2,6	1,7	0,8

(5)

or

8-5=3

Nowadays the term oxidation state is frequently used for valence. Consider the two oxygen containing compounds: OF_2 and Na_2O. The order of electronegativity of the three elements involved in these compounds is F > O > Na. Each of the atoms of fluorine, with outer electronic configuration $2s^2 2p^5$, shares one electron with oxygen in the OF_2 molecule. Being highest electronegative element, fluorine is given oxidation state –1. Since there are two fluorine atoms in this molecule, oxygen with outer electronic configuration $2s^2 2p^4$ shares two electrons with fluorine atoms and thereby exhibits oxidation state +2.



In Na_2O, oxygen being more electronegative accepts two electrons, one from each of the two sodium atoms and, thus, shows oxidation state –2. On the other hand sodium with electronic configuration 3s1 loses one electron to oxygen and is given oxidation state +1. Thus, the oxidation state of an element in a particular compound can be defined as the charge acquired by its atom on the basis of electronegative consideration from other atoms in the molecule.

Na_2O Na^{+1} O^{2-}

Low EN — — High EN

ClNa ✗ NaCl ✓

Table 3.9 Periodic Trends in Valence of Elements as shown by the Formulas of Their Compounds

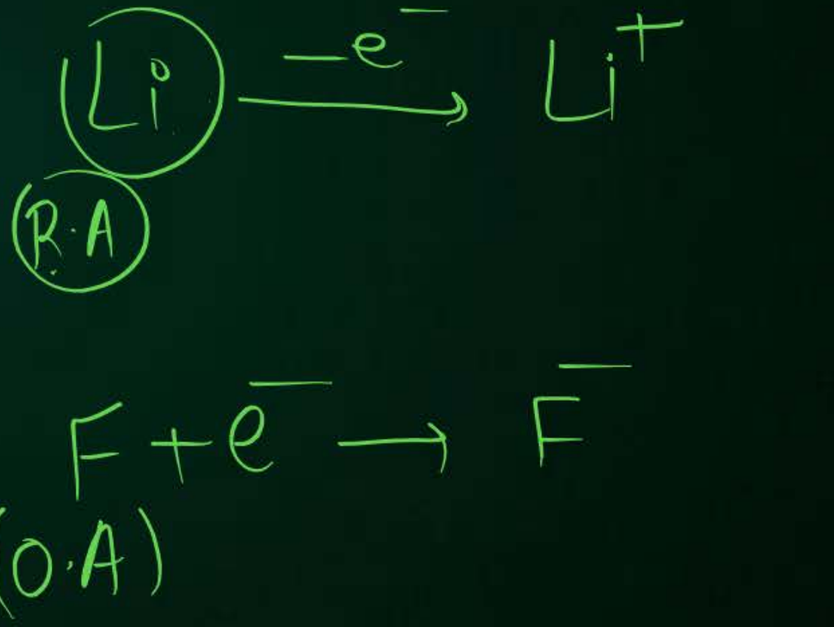
Group	1	2	13	14	15	16	17
Formula of hydride	LiH NaH KH	CaH_2	B_2H_6 AlH_3	CH_4 SiH_4 GeH_4 SnH_4	NH_3 PH_3 AsH_3	H_2O H_2S H_2Se H_2Te	HF HCl HBr HI
Formula of oxide	Li_2O Na_2O K_2O	MgO CaO SrO BaO	B_2O_3 Al_2O_3 Ga_2O_3 In_2O_3	CO_2 SiO_2 GeO_2 SnO_2 PbO_2	N_2O_3, N_2O_5 P_4O_6, P_4O_{10} As_2O_3, As_2O_5 Sb_2O_3, Sb_2O_5 Bi_2O_3 –	SO_3 SeO_3 TeO_3 –	– Cl_2O_7 – –

+3 +5

The atomic and ionic radii, as we know, generally decrease in a period from left to right. As a consequence, the ionization enthalpies generally increase (with some exceptions as outlined in section and electron gain enthalpies become more negative across a period. In other words, the ionization enthalpy of the extreme left element in a period is the least and the electron gain enthalpy of the element on the extreme right is the highest negative (note : noble gases having completely filled shells have rather positive electron gain enthalpy values).

This results into high chemical reactivity at the two extremes and the lowest in the centre. Thus, the maximum chemical reactivity at the extreme left (among alkali metals) is exhibited by the loss of an electron leading to the formation of a cation and at the extreme right (among halogens) shown by the gain of an electron forming an anion.

This property can be related with the reducing and oxidizing behaviour of the elements which you will learn later. However, here it can be directly related to the metallic and non-metallic character of elements. Thus, the metallic character of an element, which is highest at the extremely left decreases and the non-metallic character increases while moving from left to right across the period.

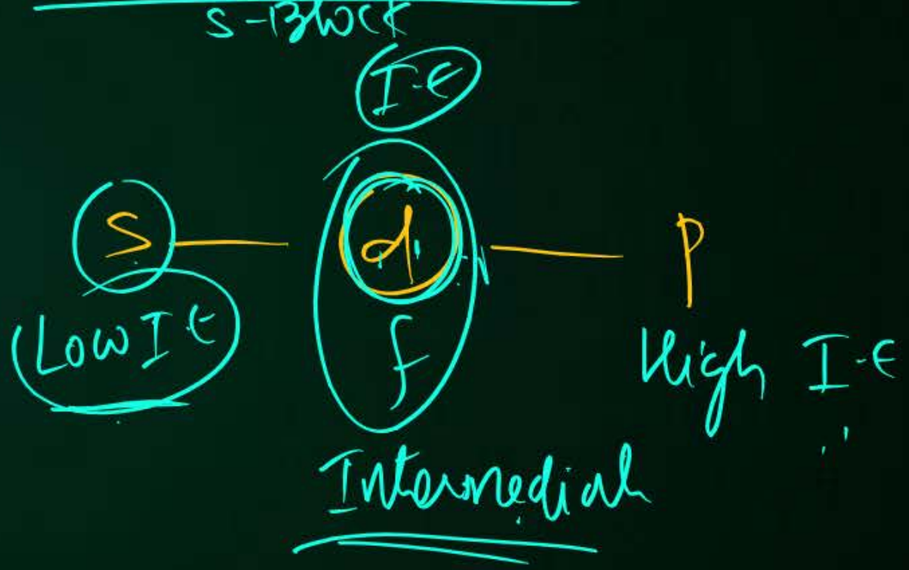


The normal oxide formed by the element on extreme left is the most basic (e.g., Na_2O), whereas that formed by the element on extreme right is the most acidic (e.g., Cl_2O_7). Oxides of elements in the centre are amphoteric (e.g., Al_2O_3, As_2O_3) or neutral (e.g., CO, NO, N_2O). Amphoteric oxides behave as acidic with bases and as basic with acids, whereas neutral oxides have no acidic or basic properties.

d-Block

≃ 5 nm

Among transition metals (3d series), the change in atomic radii is much smaller as compared to those of representative elements across the period. The change in atomic radii is still smaller among inner-transition (f-Block) metals (4f series). The ionization enthalpies are intermediate between those of s- and p-blocks. As a consequence, they are less electropositive than group 1 and 2 metals.



Thus, the metallic character increases down the group and non-metallic character decreases. This trend can be related with their reducing and oxidizing property which you will learn later. In the case of transition elements, however, a reverse trend is observed. This can be explained in terms of atomic size and ionization enthalpy.

QUESTION

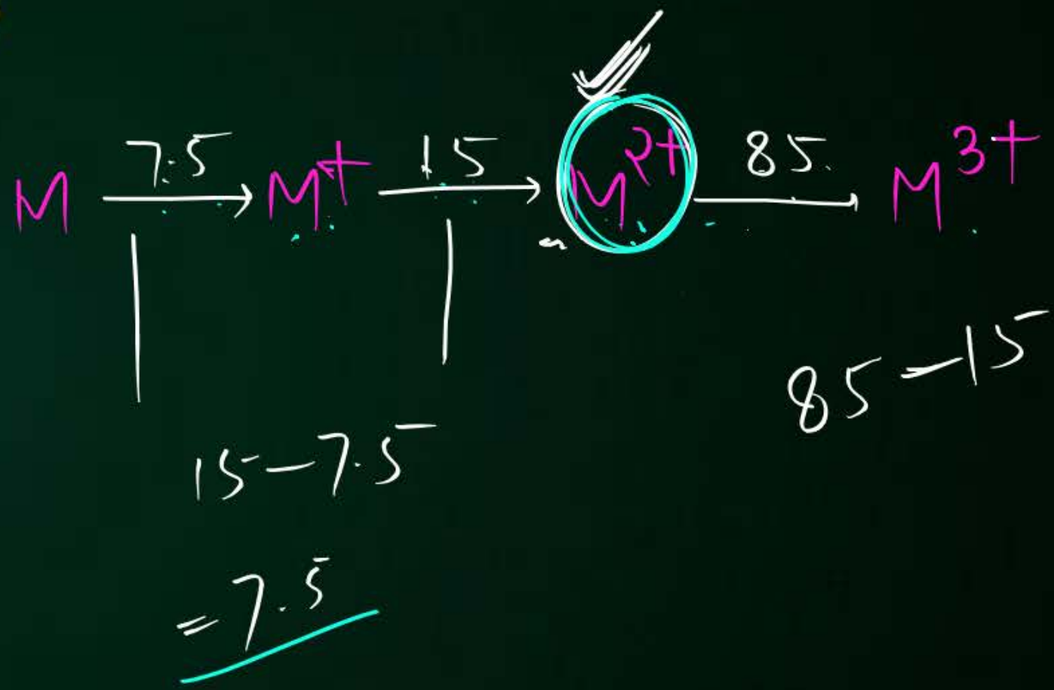
In which of the following change, observed energy represent first ionization energy of given element ?

1. $Na(s) \rightarrow Na^{+}(g)$
2. $1/2F_2(g) \rightarrow F^{+}(g)$
3. $Mg(g) \rightarrow Mg^{+2}(g)$
4. $Cl(g) \rightarrow Cl^{+}(g)$

QUESTION

Three successive I.P. value of an element is 7.5 eV, 15 eV and 85 eV. The most stable oxidation state of element is :

1. M^{+}
2. M^{+2}
3. M^{+3}
4. Cannot predicated



QUESTION

The second ionization energy is maximum for :

1. Boron $2s^2 2p^1$ $2s^2$ $s^1 < s^2$
2. Beryllium $2s^2$ $2s^1$
3. Magnesium $3s^2$ $3s^1$ X
4. Aluminium $3s^2 3p^1$ $3s^2$ X

QUESTION

Element which have maximum and minimum electron gain enthalpy in chalcogen family are respectively :

(oxygen)

1. O, Po
2. S, Po
3. S, O
4. O, S

S > Se > Te > Po > O

QUESTION

Xe has maximum EN in :

O.S ↑ EN ↑

1. XeF_2
2. XeF_4
3. $XeOF_4$
4. Equal EN in all compounds

QUESTION

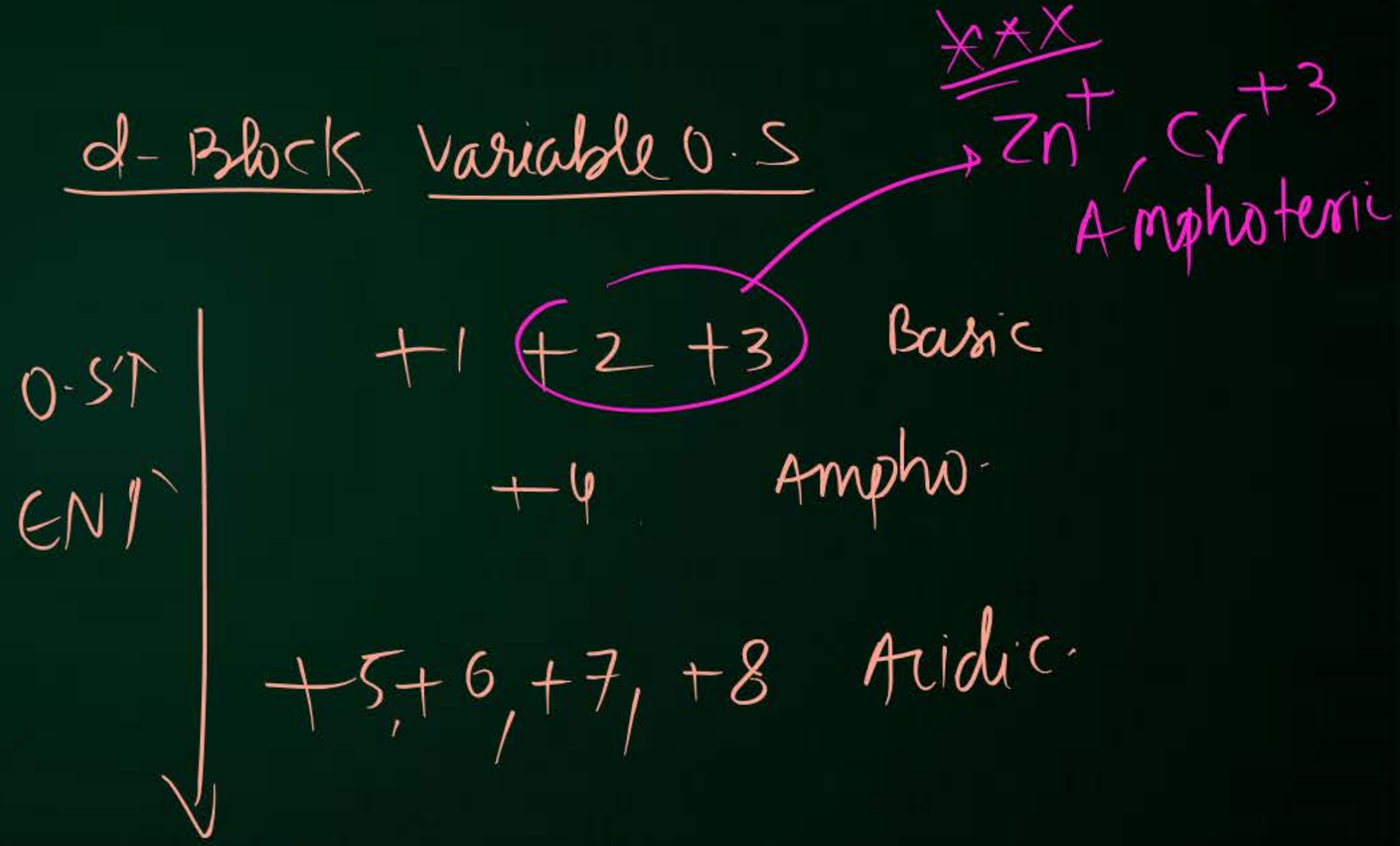
Following are neutral oxides except :

1. NO
2. N_2O
3. CO
4. NO_2 Acidic

QUESTION

Which of the following oxide is Acidic ?

1. N_2O_5
2. Mn_2O_7
3. CrO_3
4. All



QUESTION

Which compound strongly absorb CO_2 ?

Acidic

1. BeO
2. K_2O
3. H_3PO_4
4. P_4O_6

QUESTION

Which of the following salt has maximum pH in aqueous solution ?

H_2O

$H^+ \{ OH^-$

1. $AlCl_3$ $Al(OH)_3$
2. $ZnCl_2$ $Zn(OH)_2$
3. $BaCl_2$ $Ba(OH)_2$ ✓
4. $MgCl_2$ $Mg(OH)_2$

QUESTION

Correct basic strength order is

1. $Er(OH)_3 > Nd(OH)_3 > Pm(OH)_3 > Sm(OH)_3$
2. $Nd(OH)_3 > Sm(OH)_3 > Pm(OH)_3 > Er(OH)_3$
3. $Nd(OH)_3 > Pm(OH)_3 > Sm(OH)_3 > Er(OH)_3$
4. $Er(OH)_3 > Pm(OH)_3 > Sm(OH)_3 > Nd(OH)_3$

EN

f - Block

Lanthanoids

gen. L → R Size ↓

$Ce^{+3} \longrightarrow Lu^{3+}$

EN ↑

Acidic ↑

Basic ↓

QUESTION

Assertion : Elements of a period exhibits similar chemical properties.
Reason : Elements of a group possess same electronic configuration of their outermost shell.

1. Both assertion and reason are correct and reason is correct for the assertion
2. Both assertion and reason are correct and reason is not correct for the assertion
3. Assertion is correct but reason is correct
4. Assertion is incorrect but reason is correct

QUESTION

NOTES

Mg Valq Example

Assertion : Alkaline earth metals show +2 oxidation state.

Reason : IP_2 and IP_3 is more than 16 eV for IIA metals.

group 2

1. Both assertion and reason are correct and reason is correct for the assertion
2. Both assertion and reason are correct and reason is not correct for the assertion
3. Assertion is correct but reason is correct
4. Assertion is incorrect but reason is correct

IE_1 IE_2 } IE_3 IE_4

QUESTION

Assertion : Ionization energy of Ne is greater as compare of Ne^+. ✗
Reason : Ne has p^6 (full filled electronic configuration) but Ne^+ has p^5 configuration of outermost subshell. ✓ But not Correct Explanation.

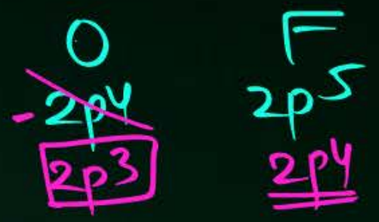
1. Both assertion and reason are correct and reason is correct for the assertion
2. Both assertion and reason are correct and reason is not correct for the assertion
3. Assertion is correct but reason is correct
4. Assertion is incorrect but reason is correct ✓

QUESTION

Assertion : I.P. of first element in a period is minimum.
Reason : Effective nuclear charge of first element in a period is minimum.

1. Both assertion and reason are correct and reason is correct for the assertion
2. Both assertion and reason are correct and reason is not correct for the assertion
3. Assertion is correct but reason is correct
4. Assertion is incorrect but reason is correct

QUESTION



Assertion : Second IP of oxygen is greater than that of fluorine.
Reason : Oxygen acquires stable half filled electronic configuration after loosing one electron.

1. Both assertion and reason are correct and reason is correct for the assertion
2. Both assertion and reason are correct and reason is not correct for the assertion
3. Assertion is correct but reason is correct
4. Assertion is incorrect but reason is correct

QUESTION

Which of the following is the most basic oxide ?

[AIPMT - 2006]

1. SeO_2
2. Al_2O_3
3. Sb_2O_3
4. Bi_2O_3

QUESTION

Which of the following oxides is not expected to react with sodium hydroxide ?

[AIPMT - 2009]

1. BeO
2. B_2O_3
3. CaO
4. SiO_2

NaOH Base.

Basic

QUESTION

Reason of lanthanoid contraction is :

[AIPMT - 2014]

1. Negligible screening effect of '4f' e^-

2. Increasing nuclear charge

3. Decreasing nuclear charge

4. Decreasing screening effect

QUESTION

Which of the following statement is incorrect for an atom having electronic configuration 2, 8, 7

[AIPMT 1995]

1. It forms diatomic molecules Cl_2
2. It is a non metal element
3. Its valency is 1
4. It forms basic oxide

Cl

$1s^2$ $2s^2$ $2p^6$ $3s^2$ $3p^5$

2 8 7

QUESTION

Electronegativity is the measurement of capacity of an atom by which :

[AIPMT 1996]

1. Electrons get replled
2. Electrons get attracted
3. Gain of electron
4. Lose of proton

H.W

QUESTION

A transition element X has the configuration [Ar] $3d^4$ in its +3 oxidation state. Its atomic number is

[AIPMT 1996]

18 + 4 + 3

$Z = 25$

1. 25
2. 26
3. 22
4. 19

QUESTION

Which one of the following arrangements represents the correct order of electron gain enthalpy (with negative sign) of the given atomic species :-

[AIPMT 2005]

1. F < Cl < O < S
2. S < O < Cl < F
3. O < S < F < Cl
4. Cl < F < S < O

H.W

O < S < F < Cl

NOTES

QUESTION

The correct order regarding the electronegativity of hybrid orbitals of carbon is ?

[AIPMT 2006]

1. $sp < sp^2 < sp^3$

2. $sp > sp^2 < sp$

3. $sp > sp^2 > sp^3$

4. $sp < sp^2 > sp^3$

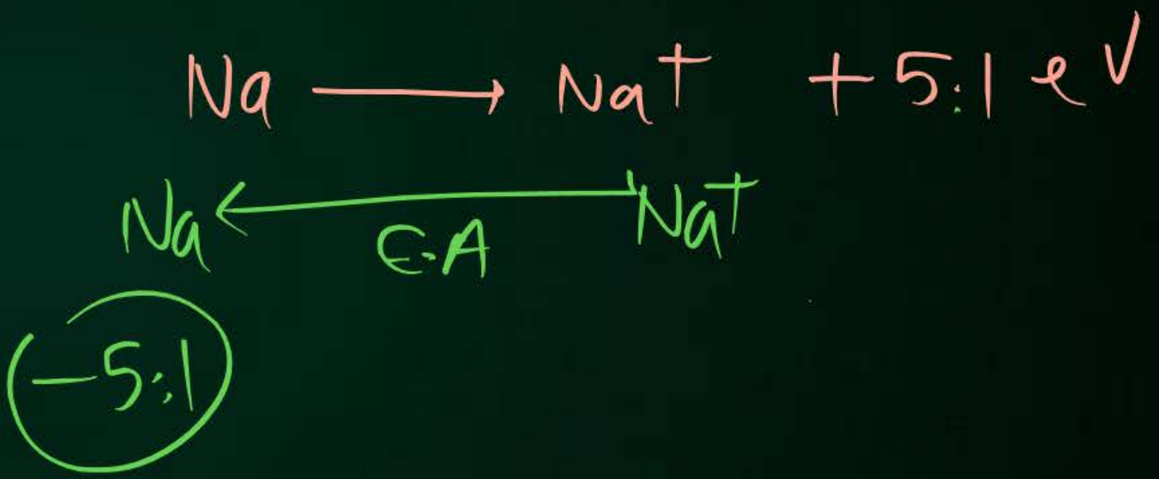
H.W

QUESTION

What is the value of electron gain enthalpy of Na^+ if IE_1 of Na = 5.1 eV :-

[AIPMT Mains 2011]

1. +0.2 eV
2. −5.1 eV
3. −10.2 eV
4. +2.55 eV

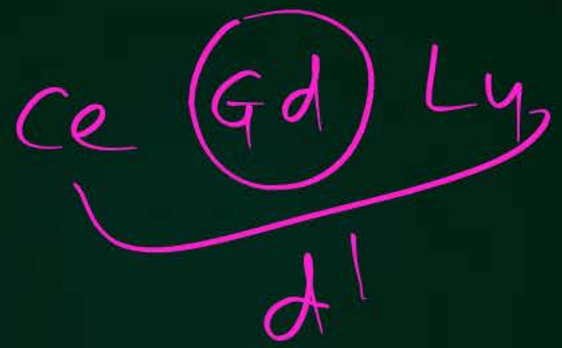


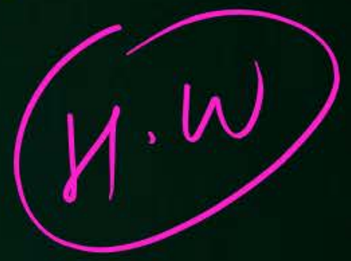
QUESTION

Gadolinium belongs to 4f series. It's atomic number is 64. Which of the following is the correct electronic configuration of gadolinium ?

[Re AIPMT 2015]

1. [Xe] $4f^7\ 5d^1 6s^2$
2. [Xe] $4f^6 5d^2 6s^2$
3. [Xe] $4f^8 6d^2$
4. [Xe] $4f^9 5s^1$





QUESTION

Which of the following oxides is most acidic in nature?

[NEET-2018]

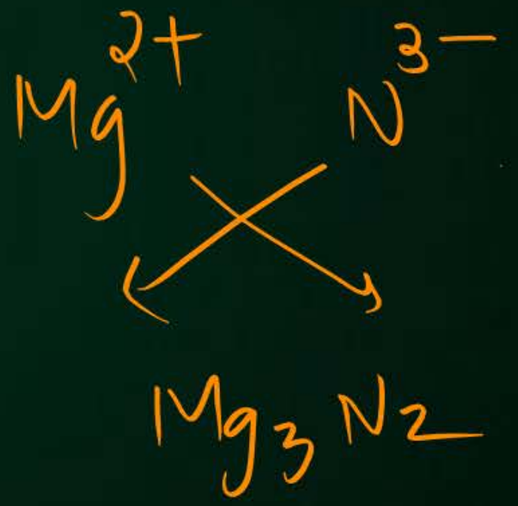
1. MgO
2. BeO
3. BaO
4. CaO

QUESTION

Magnesium reacts with an element (X) to form an ionic compound. If the ground state electronic configuration of (X) is $1s^2\ 2s^2\ 2p^3$, the simplest formula for this compound is :

[NEET-2018]

1. Mg_2X_3
2. MgX_2
3. Mg_2X
4. Mg_3X_2



QUESTION

Consider the isoelectronic species, Na^+, Mg^{2+}, F^- and O^{2-}. The correct order of increasing length of their radii is _____.

1. $F^- < O^{2-} < Mg^{2+} < Na^+$

H.W

2. $Mg^{2+} < Na^+ < F^- < O^{2-}$

3. $O^{2-} < F^- < Na^+ < Mg^2$

4. $O^{2-} < F^- < Mg^{2+} < Na^+$

QUESTION

Which of the following is not an actinoid ?

1. Curium (Z = 96)
2. Californium (Z = 98)
3. Uranium (Z = 92)
4. Terbium (Z = 65)

HW

QUESTION

The order of screening effect of electrons of s, p, d and f orbitals of a given shell of an atom on its outer shell electrons is :

1. $s > p > d > f$
2. $f > d > p > s$
3. $f < d < s < p$
4. $f > p > s > d$

H.W

QUESTION

The first ionization enthalpies of Na, Mg, Al and Si are in the order :

1. Na < Mg < Si < Al

2. Na > Mg > Al > Si

3. Na < Al < Mg < Si

4. Na > Al > Mg > Si

H.W

QUESTION

The electronic configuration of gadolinium (Atomic number 64) is

H.W

1. $[Xe]\ 4f^3\ 5d^5\ 6s^2$
2. $[Xe]\ 4f^7\ 5d^2\ 6s^1$
3. $[Xe]\ 4f^7\ 5d^1\ 6s^2$
4. $[Xe]\ 4f^8\ 5d^6\ 6s^2$

QUESTION

The statement that is not correct for periodic classification of elements is :

1. The properties of elements are periodic function of their atomic numbers.
2. Non metallic elements are less in number than metallic elements.
3. For transition elements, the 3d-orbitals are filled with electrons after 3p-orbitals and before 4s-orbitals.
4. The first ionisation enthalpies of elements generally increase with increase in atomic number as we go along a period.

3s → 3p → | 4s → 3d → 4p |

n = 3 | n = 4

QUESTION

Among halogens, the correct order of amount of energy released in electron gain (electron gain enthalpy) is :

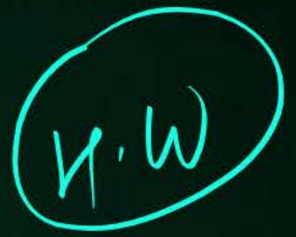
H.W

1. $F > Cl > Br > I$
2. $F < Cl < Br < I$
3. $F < Cl > Br > I$
4. $F < Cl < Br < I$

QUESTION

The elements in which electrons are progressively filled in 4f-orbital are called

1. actinoids
2. transition elements
3. lanthanoids
4. halogens



QUESTION

Which of the following is the correct order of size of the given species.

1. $I > I^- > I^+$
2. $I^+ > I^- > I$
3. $I > I^+ > I$
4. $I^- > I > I^+$

H.W

QUESTION

The element with atomic number 57 belongs to

1. s-block
2. p-block
3. d-block
4. f-block

QUESTION

The last element of the p-block in 6^{th} period is represented by the outermost electronic configuration.

1. $7s^2\ 7p^6$

2. $5f^{14}\ 6d^{10}\ 7s^2\ 7p^0$

3. $4f^{14}\ 5d^{10}\ 6s^2\ 6p^6 4f^{14}\ 5d^{10}\ 6s^2\ 6p^6$

4. $4f^{14}\ 5d^{10}\ 6s^2\ 6p^4$

H.W

QUESTION

Which of the elements whose atomic number are given below, cannot be accommodate in the present set up of the long form of the periodic table

H.W

1. 107
2. 118
3. 126
4. 102

QUESTION

The electronic configuration of the element which is just above the element with atomic number 43 in the same group is _____.

1. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5 4s^2$
2. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5 4s^3\ 4p^6$
3. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^6 4s^2$
4. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^7 4s^2$

Sc Ti V Cr Mn.
21 22 23 24 25

39 40 41 42 43 Tc

QUESTION

The element with atomic numbers 35, 53, and 85 are all _____ .

H.W

1. noble gases
2. halogens
3. heavy metals
4. light metals

QUESTION

Electronic configurations of four elements A, B, C and D are given below :

(a) $1s^2\ 2s^2\ 2p^6$ Ne

(b) $1s^2\ 2s^2\ 2p^4$ O

(c) $1s^2\ 2s^2\ 2p^6\ 3s^1$ Na

(d) $1s^2\ 2s^2\ 2p^5$ F

Which of the following is the correct order of increasing tendency to gain electron :

EA

1. a < c < b < d
2. a < b < c < d
3. d < b < c < a
4. d < a < b < c

QUESTION

Which of the following represents the correct order of increasing first ionization enthalpy for Ca, Ba, S, Se and Ar ?

[JEE Mains 2013]

1. Ba < Ca < Se < S < Ar
2. Ca < Ba < S < Se < Ar
3. Ca < S < Ba < Se < Ar
4. S < Se < Ca < Ba < Ar

Metals ⇒ I.E Low

Ca

Ba

QUESTION

The second ionization potentials in electron volts of oxygen and fluorine atoms are respectively given by :

H.W

1. 35.1, 38.3
2. 38.3, 38.3
3. 38.3, 35.1
4. 35.1, 35.1

QUESTION

Successive ionization energies of an element 'X' are given below (in kcal) :

IP_1	IP_2	IP_3	IP_4
165	195	556	595

Electronic configuration of the element X is :

H.W

1. $1s^2, 2s^2 2p^6, 3s^3 3p^2$
2. $1s^2, 2s^1$
3. $1s^2, 2s^2 2p^2$
4. $1s^2, 2s^2 2p^6, 3s^2$

QUESTION

In the process, $Cl(g) + e^- \xrightarrow{\Delta H} Cl^-(g)$, ΔH is :

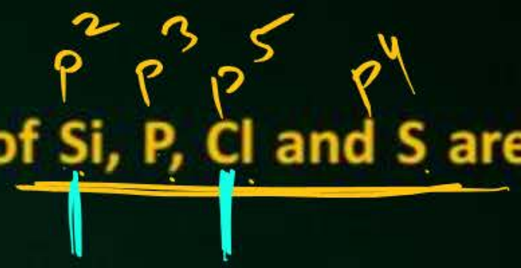
1. Positive
2. Negative
3. Zero
4. None of these

H.W

QUESTION

The correct values of ionization energies (in kJ mol^{-1}) of Si, P, Cl and S are respectively :

1. 786, 1012, 999, 1256
2. 1012, 786, 999, 1256
3. 786, 1012, 1256, 999
4. 786, 999, 1012, 1256



QUESTION

Series-I : $[N^{3-}, O^{-}, Na^{+}]$; Series-II : $[N^{+}, C^{+}, O^{+}]$

Choose the species of lowest I.P. from series-I and highest I.P. from series-II respectively :

1. N^{3-}, O^{+}
2. Na^{+}, C^{+}
3. N^{3-}, N^{+}
4. O^{-}, C^{+}

QUESTION

The first ionization potentials (eV) of Be and B respectively are :

1. 8.29 eV, 9.32 eV
2. 9.32 eV, 9.32 eV
3. 8.29 eV, 8.29 eV
4. 9.32 eV, 8.29 eV

Be > B

$2s^2 > 2p^1$

p. p

QUESTION

Match the column-I (Elements) with column-II (Configuration of elements)

	Column I		Column II
1	The third alkali metal	(D)	(P) $1s^2 2s^2 2p^6 3s^2 3p^5$
2	The second transition element	(R)	(Q) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6$
3	The fourth noble gas element	(Q)	(R) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^2 4s^2$
4	The second halogen element	(P)	(D) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$

QUESTION

Which one of the following sets of ions represents a collection of isoelectronic species?

(Given Atomic Number: F:9, Cl:17, Na = 11,Mg =12, Al =13, K=19, Ca =20, Sc = 21)

[JEE Main-2023]

H.W

1. $N^{3-}, O^{2-}, F^{-}, S^{2-}$
2. $K^{+}, Cl^{-}, Ca^{2+}, Sc^{3+}$
3. $Ba^{2+}, Sr^{2+}, K^{+}, Ca^{2+}$
4. $Li^{+}, Na^{+}, Mg^{2+}, Ca^{2+}$

QUESTION

Which of the following represents the correct order of metallic character of the given elements? [JEE Main-2023]

1. Si < Be < Mg < K
2. Be < Si < Mg < K
3. K < Mg < Be < Si
4. Be < Si < K < Mg

QUESTION

Element having maximum EN is :

1. Li
2. Be
3. C
4. O

H.W

QUESTION

Ionization energy of nitrogen is more than oxygen due to :

1. Increased attraction of electron towards nucleus

H.W

2. Extra stability of half filled 'p' orbital

3. Small size of N_2

4. None of the above

QUESTION

In the general electronic configuration -
$(n-2)f^{1-14}\ (n-1)d^{0-1}\ ns^2$, if value of n = 7 the configuration will be of -

1. Lanthenides
2. Actinides
3. Transition elements
4. None

QUESTION

The radius of potassium atom is 0.203 nm. The radius of the potassium ion in nanometer will be :

1. 0.133
2. 0.231
3. 0.234
4. 0.251

$K = 0.203$

$K^+ = ?$

$K > K^+$

QUESTION

The best reason to account for the general tendency of atomic diameters to decrease as the atomic numbers increase within a period of the periodic table is the fact that :

1. Outer electrons repel inner electrons

H.W

2. Closer packing among the nuclear particles is achieved

3. The number of neutrons increases

4. The increasing nuclear charge exerts a greater attractive force on the electrons

QUESTION

Which of the following transitions involves maximum energy ?

1. $M^-(g) \rightarrow M(g)$
2. $M^{2+}(g) \rightarrow M^{3+}(g)$
3. $M^+(g) \rightarrow M^{2+}(g)$
4. $M(g) \rightarrow M^+(g)$

$M^- \xrightarrow{\varepsilon_1} M \xrightarrow{\varepsilon_2} M^+ \xrightarrow{\varepsilon_3} M^{2+} \xrightarrow{\varepsilon_4} M^{3+}$

$\varepsilon_1 < \varepsilon_2 < \varepsilon_3 < \varepsilon_4$

QUESTION

In which case, the energy is not released ?

1. $Cl \rightarrow Cl^-$
2. $P \rightarrow P^-$
3. $N \rightarrow N^-$
4. $C \rightarrow C^-$

QUESTION

The radius of isoelectronic series :

1. Decreases with decreasing nuclear charge

H.W

2. Decreases with increasing effective nuclear charge

3. Same for all

4. First increases then decreses

QUESTION

The correct order of size for oxygen, species O, O^-, O^+ is :

1. $O > O^- > O^+$
2. $O > O^+ > O^-$
3. $O^+ > O^- > O$
4. $O^- > O > O^+$

H.W

QUESTION

A neutral atom (Ar) is converted to (A^{3+}) by the following process

$$Ar \xrightarrow[-e]{E_1} Ar^{+} \xrightarrow[-e]{E_2} Ar^{2+} \xrightarrow[-e]{E_3} Ar^{3+}$$

The correct order of E_1, E_2 and E_3 energies is :

1. $E_1 < E_2 < E_3$
2. $E_1 > E_2 > E_3$
3. $E_1 = E_2 = E_3$
4. $E_1 > E_2 < E_3$

H.W

QUESTION

Assign true (T) or false (F) for following statements and select correct option for your answer.

(i) I.P. of $O_{(g)}$ is less than I.P. of $O^-_{(g)}$

(ii) I.P. of $Ne_{(g)}$ is greater than I.P. of $Ne^+_{(g)}$

(iii) E.A. of $O^+_{(g)}$ is greater than E.A. of $O_{(g)}$

(iv) I.P. of $N_{(g)}$ is greater than I.P. of $N^+_{(g)}$

$O < O^-$ X

$Ne > Ne^+$ X

$O^+ > O$ ✓

$N > N^+$ X

1. F, F, T, F
2. T, T, T, T
3. T, T, T, F
4. F, T, F, T

QUESTION

The electronic configuration of four element are :

(i) $[Xe]6s^2$ (ii) $[Xe]4f_{14}5d_16s^2$

(iii) $[Ar]3d^{10}4s^24p^5$ (iv) $[Ar]3d^74s^2$

Which one of the following statements about these elements is not true ?

1. (i) is a strong reducing agent
2. (ii) is a d-block element
3. (iii) has high negative electron gain enthalpy
4. (iv) Show variable oxidation states

QUESTION

The correct electron affinity order of N, O, S, Cl is :

1. O < N < Cl < S
2. Cl > O > S > N
3. N < O < S < Cl
4. N = Cl > O = S

QUESTION

Match the matrix.

	Column-I (Decreasing order)	Column-II (Correct for)
1	I > Br > Cl > F	(P) Fist ionization energy
2	F > Cl > Br > I	(Q) Size
3	Cl > F > Br > I	(R) EA (electron affinity)
4	O > F > N > C	(S) EN (electronegativity)
		(T) Second ionization energy

Revision

Mind Map Series

Homework

Ques from Module

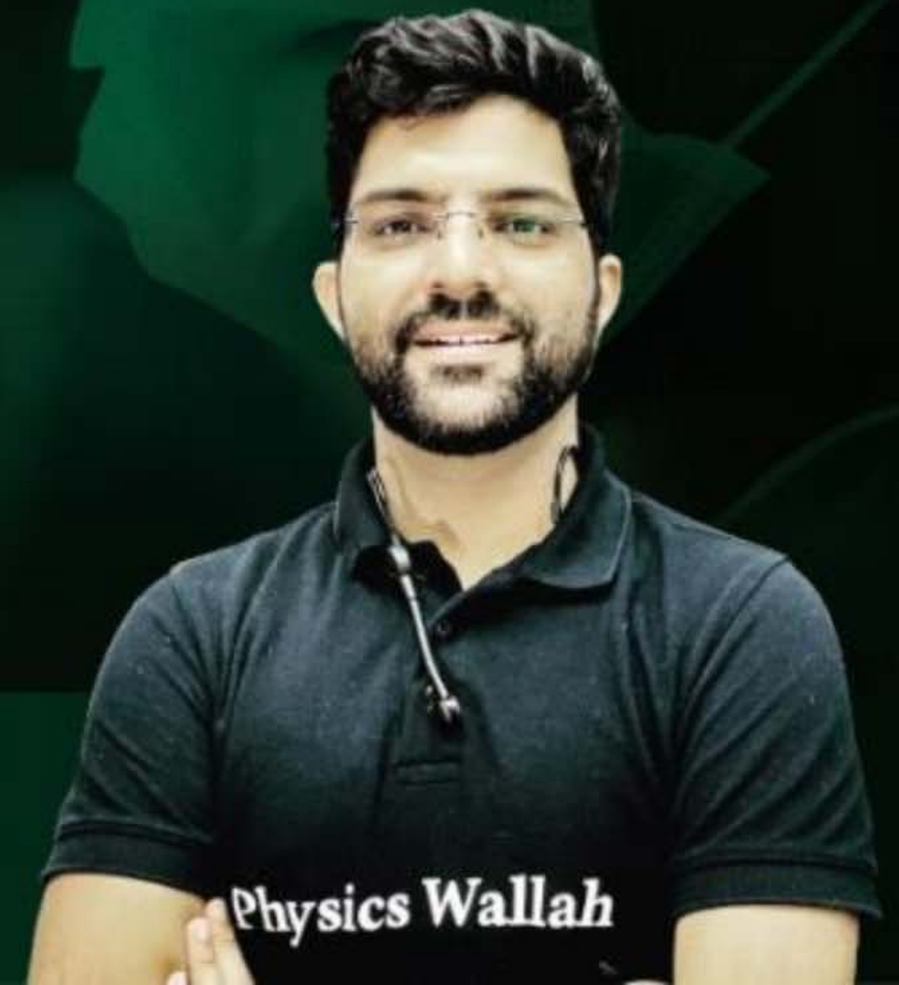
THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture - 01 | Inorganic Chemistry

Chemical Bonding and Molecular Structure



By - Mohit Dadheech (MD Sir)

Topics *to be covered*

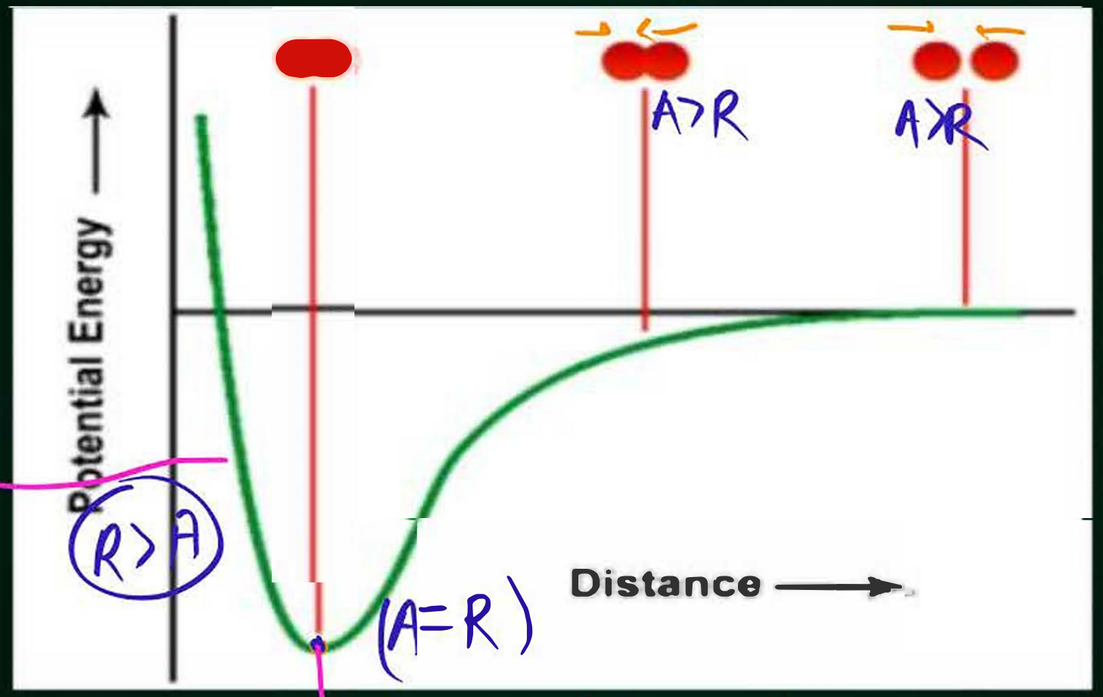
1. Introduction
2. Octet Rule
3. Formal charge

Chemical Bond :

Force of attraction present between any chemical species like atoms, ions, Molecules.

Bond formation is → Exothermic
Energy Release.

Bond dissociation → Endothermic
Energy absorb



Bond dissociation

Bond formation point
Minimum potential Energy

Why do atoms Combine?

(i) To achieve Stable outer Octet

$8e^-$

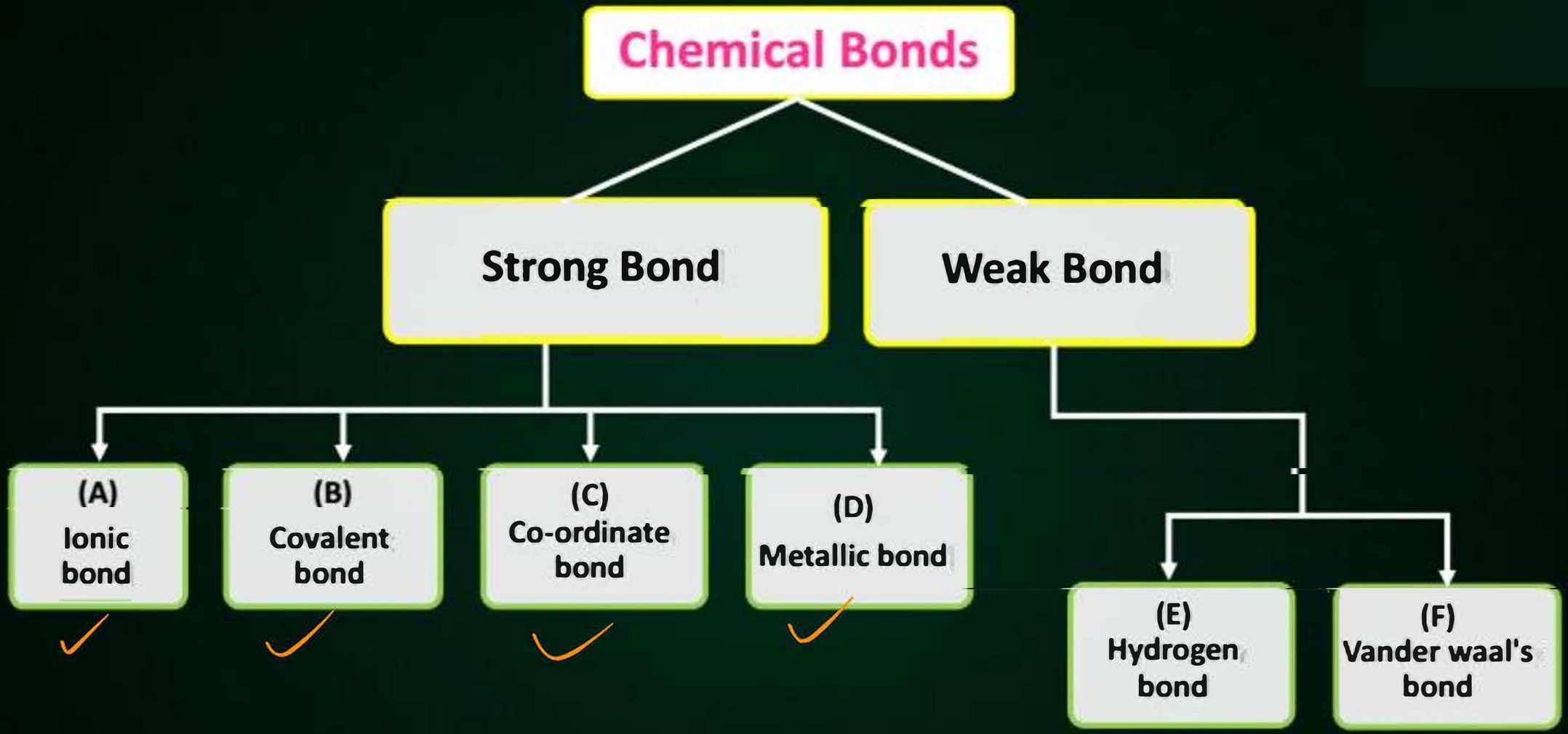
Classical Concept

$s^2 p^6$ configuration in Valence shell

$8e^-$

(ii) To achieve Minimum potential Energy State & Maximum Stability

Modern Concept


Chemical Bonds
Strong Bond
Weak Bond
(A)
Ionic bond
(B)
Covalent bond
(C)
Co-ordinate bond
(D)
Metallic bond
(E)
Hydrogen bond
(F)
Vander waal's bond

Kossel-Lewis Approach (Octet Rule) :

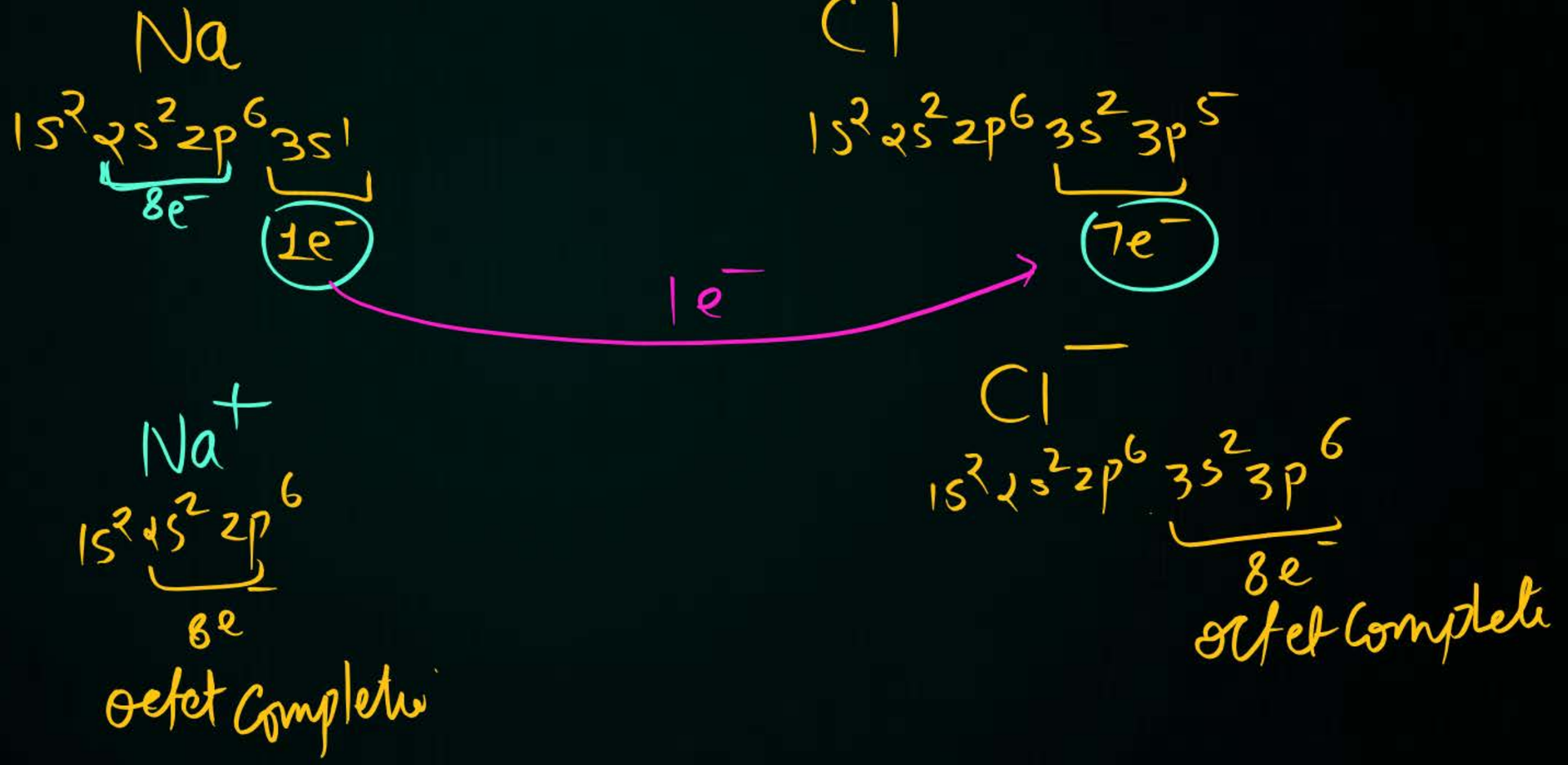
- It was based on inertness of noble gases. → $ns^2 np^6$ → $8e^-$
- Atoms can combine either by transfer of valence electrons from one atom to another (gaining or losing) or by sharing of valence electrons in order to have an octet (8 e^- in their valence shells.)
- In case of H & He duplet (2 e^- in valence shell) will be completed.

(1s) → Max $2e^-$

Lewis symbols :

Valence e^-	1	2	3	4	5	6	7	8
	$2s^1$	$2s^2$	$2s^2 2p^1$	$2s^2 2p^2$	$2s^2 2p^3$	$2s^2 2p^4$	$2s^2 2p^5$	$2s^2 2p^6$

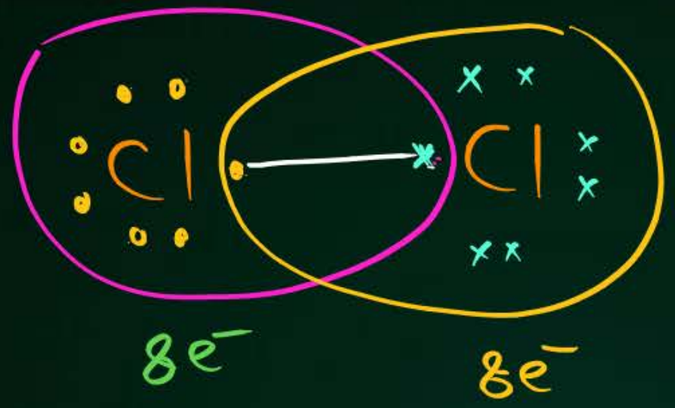
Ex octet Completion by transfer of e^-



Formation of the Cl_2, O_2, N_2 molecules :

(Ex) octet Completion by Sharing of e^-

(1) Cl_2



Bond pair $= \frac{\text{Bonding } e^-}{2}$ No. of shared e^- (Bonding e^-) $\rightarrow$ 2

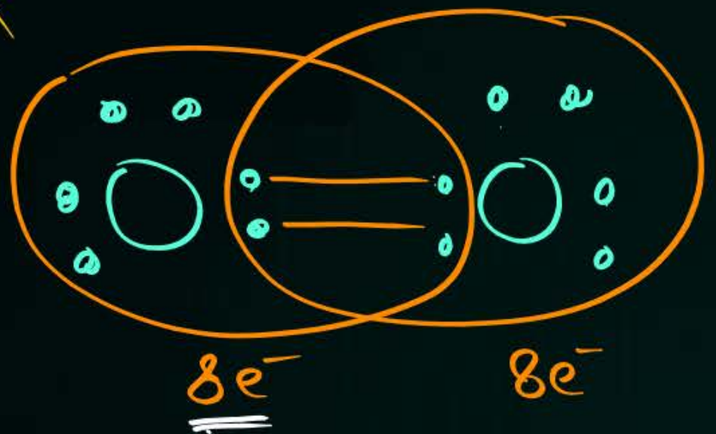
no. of non-Bonding $e^- \Rightarrow 12$

lone pair or Non Bonding pair $= \frac{12}{2} = 6$

$$\text{no. of Bonds} = \frac{\text{no. of Bonding } e^-}{2}$$

Bond pairs / no. of Bonds

(2) O_2

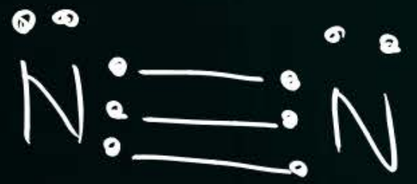


Bonding + non Bonding

Bond pairs — 2

lone pairs 4

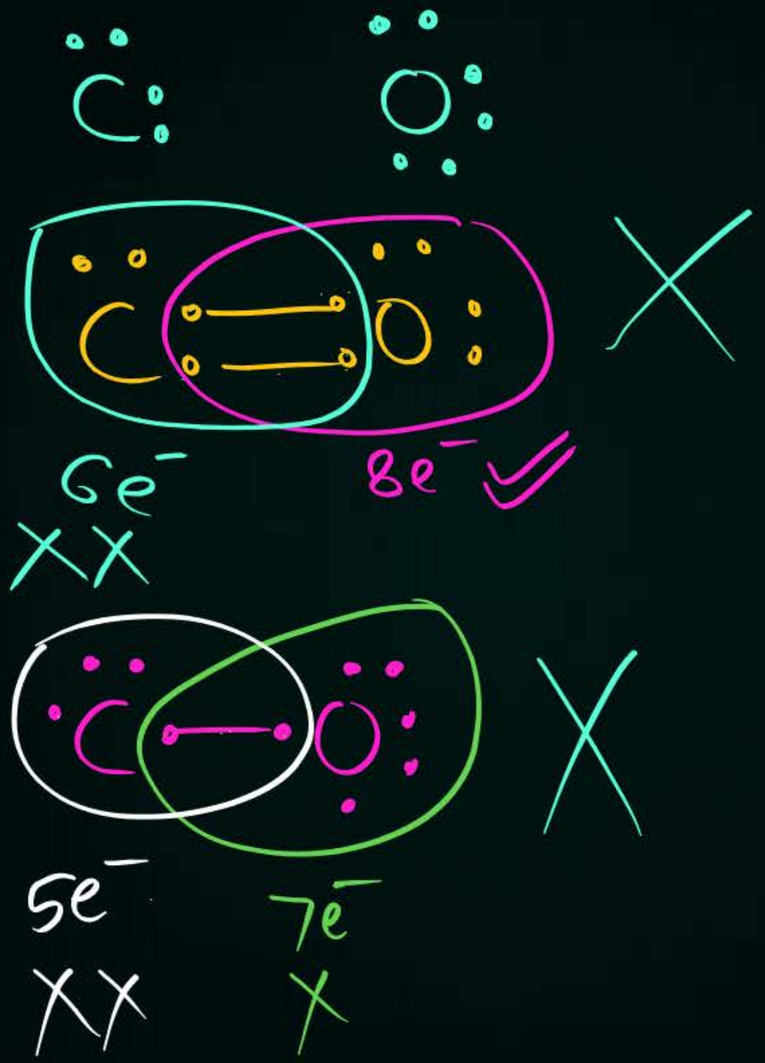
(3)

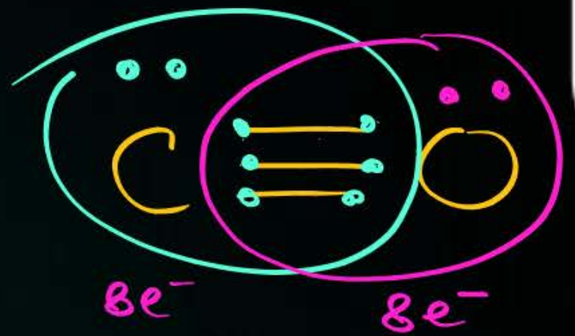


Bond pairs :— 3

lone pairs :— 2

(4) CO





How to write Lewis dot structure :

MDJ

$$\text{No. of Bonds} = \frac{\text{no. of Req. Valence } e^- \text{ (always 8)} - \text{no. of available Valence } e^-}{2}$$

For CO

$$\frac{(8+8) \quad (4+6)}{2} \quad \frac{16 - 10}{2} = \frac{6}{2} = 3 \text{ Bonds}$$

$\ddot{C} \equiv \ddot{O}$

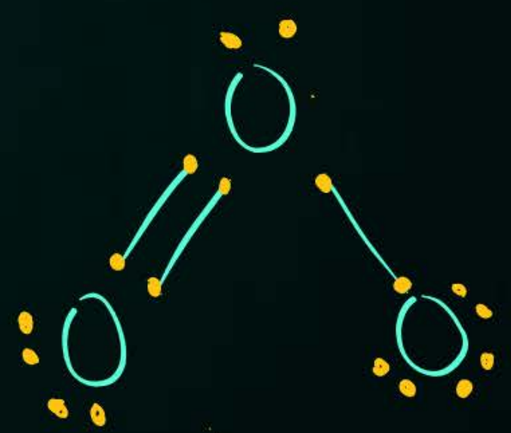
Ex O_3

$(8+8+8)$ $(6+6+6)$

$$\text{no. of Bonds} = \frac{24 - 18}{2}$$

$$\frac{6}{2} = 3$$

no. of Bonds



(3) CO_2 $\quad 8+8+8 \quad (4+6+6)$

$$= \frac{24 - 16}{2} = (4)$$ Bonds

(A)

(B)

(4) N_3^-

$(8+8+8)$ $(5+5+5+1)$

-ve charge → Extra available e^-

$$\frac{24 - 16}{2} = 4 \text{ Bonds}$$

(A)

(B)

Formal charge

(M D'J)

F.C = Jitne Hone Chahiye — Jitne Hai

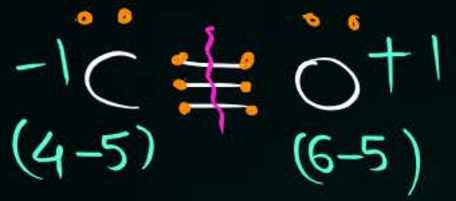
charge present on an atom in a molecule due to gain or loss of e^-

Valence e^- in Free state of atom

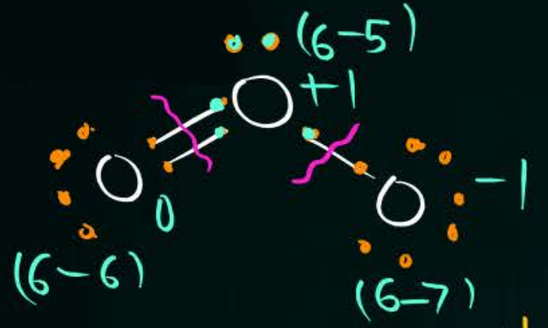
(Ex) O = 6
C = 4
N = 5
B = 3

Valence e^- in given Lewis dot structure.

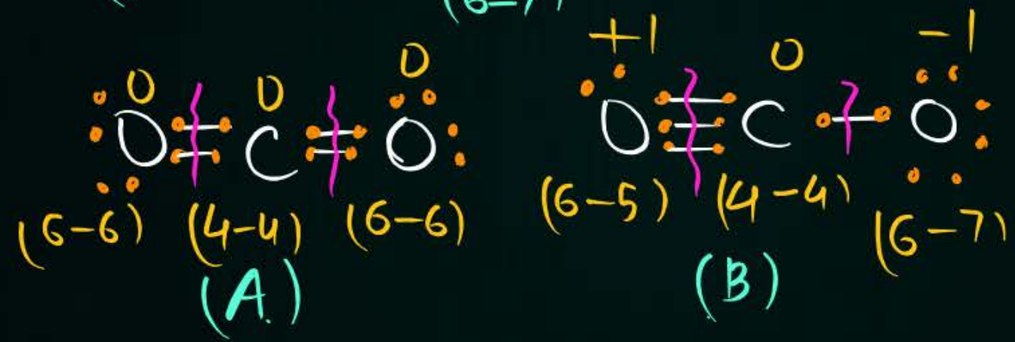
(1) CO



(2) O_3

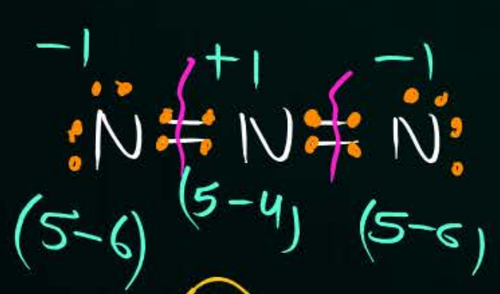


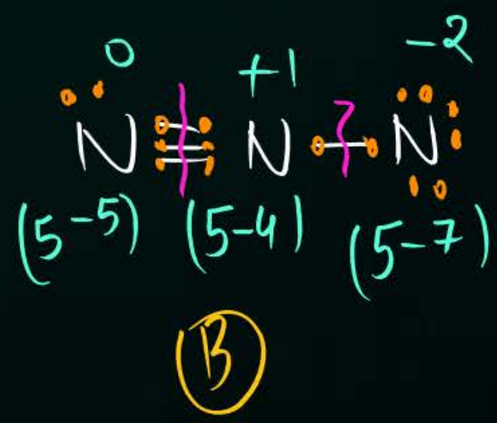
(3) CO_2



(A) is more stable due to absence of charge.

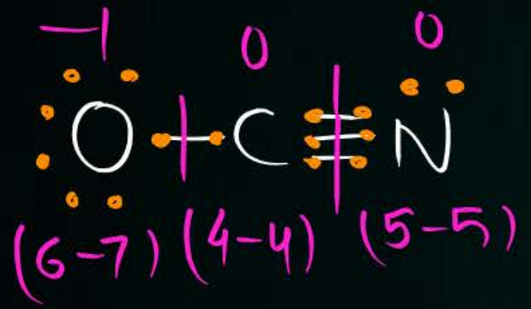
(4) N_3^-

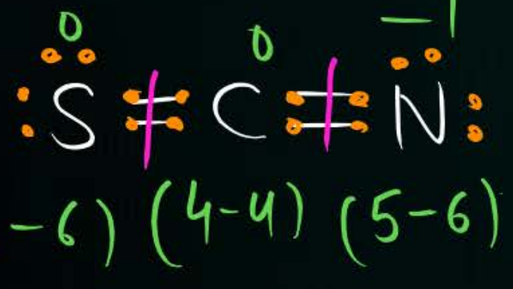




(A) is more stable due to symmetrical charge distribution.

(5) CN^- Cyanide ion.

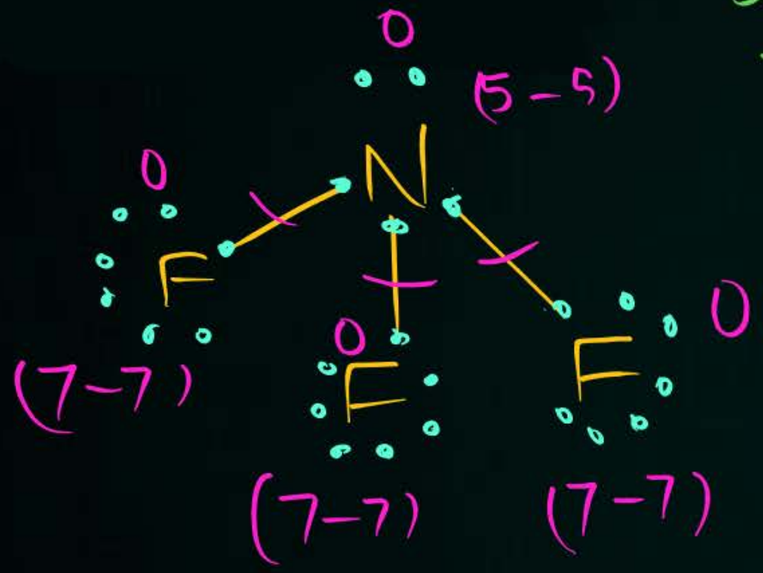
(6)  OCN^- Cyanate ion

(7)  SCN^- thiocyanate ion.

NF_3

$8 \times 4 \qquad 5 + 7 \times 3$

$$\frac{32 \text{ — } 26}{2} = \frac{6}{2} = 3$$



THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture - 02 | Inorganic Chemistry

Chemical Bonding and Molecular Structure

By - Mohit Dadheech (MD Sir)

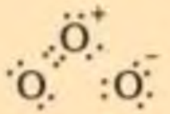
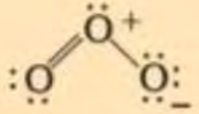
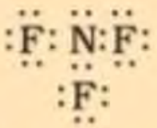
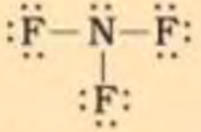
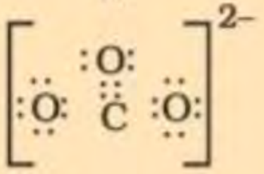
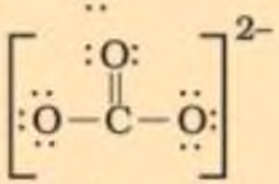
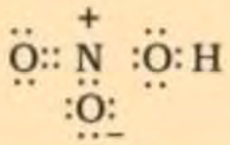
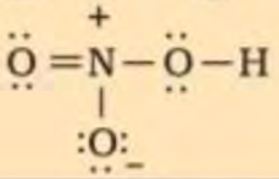
Topics *to be covered*

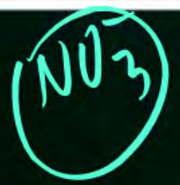
1. Formal Charge
2. Average formal charge in some important Oxo-anions
3. Coordinate Bond

Formal Charge :

Formal charge (F.C.) on an atom in a Lewis structure = [Total number of valence electrons in the free atom] − [total number of non bonding (lone pair) electrons] − 1/2 [total number of bonding(shared) electrons]

Examples given in NCERT

Molecule/Ion	Lewis Representation	
H_2	H : H*	H – H
O_2	:Ö::Ö:	:Ö=Ö:
O_3		
NF_3		
CO_3^{2-}		
HNO_3		



Limitations of Octet Rule :

(i) Existence of Hypervalent Compound → Valence e^- at central atom > 8

(ii) Existence of Hypovalent Compound → Valence e^- < 8

(iii) Odd electron species do not follow octet rule NO, NO_2

(iv) Existence of Compounds of inert gases with Oxygen & Fluorine like XeF_2, KrF_2, $XeOF_2$ etc.

(v) It does not explain the relative stability of the molecules being totally silent about the energy of a molecule.

(vi) This theory does not account for the shape of molecules.

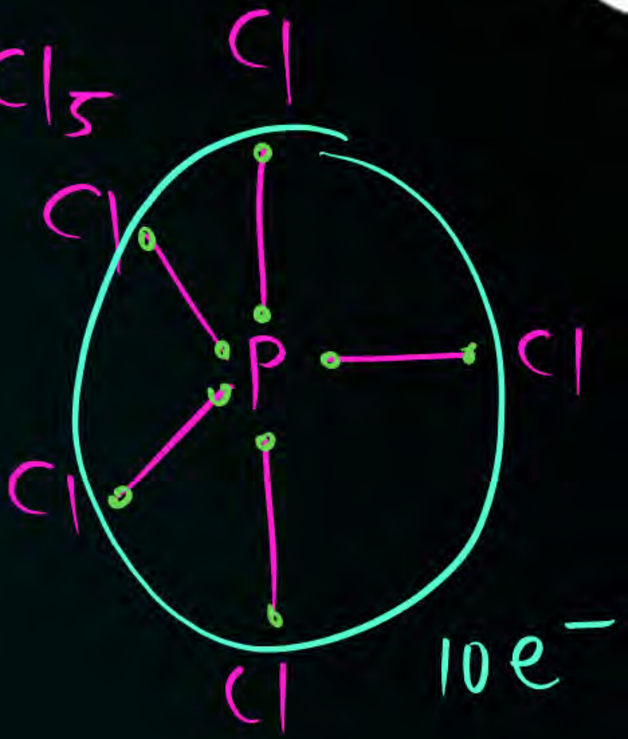
⇒ Hypervalent / Expended octet /

Valence $e^- > 8$

Ex SF_6

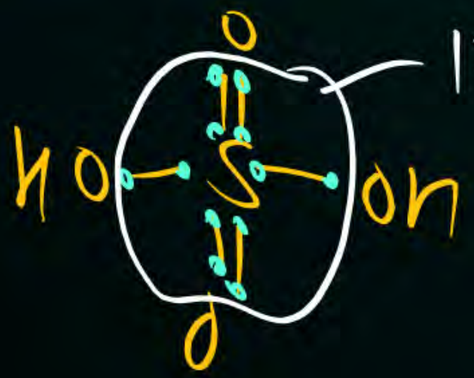
12 e^-

PCl_5



10 e^-

H_2SO_4

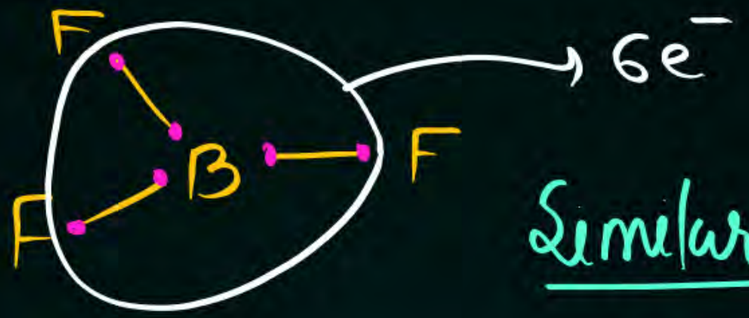


12 e^-

⇒ Hypovalent

Valence e^- < 8 → electron deficient Compounds

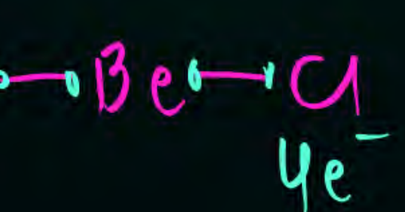
(1) BF_3



Similar Ex. BCl_3, BBr_3, BI_3
BH_3, B_2H_6

LiCl

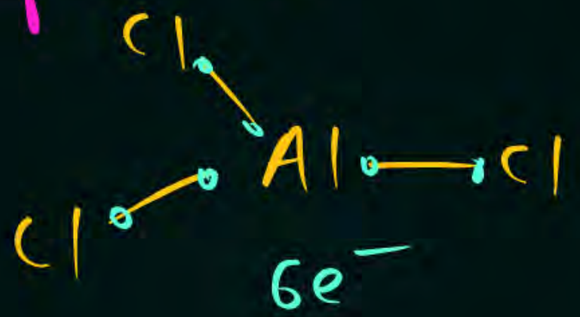
$BeCl_2$



AlF_3 → e⁻ ~~deficient~~ ∵ AlF_3 ionic Compounds.

Al^{3+} } $3F^-$

$AlCl_3$ → e⁻ deficient ✓



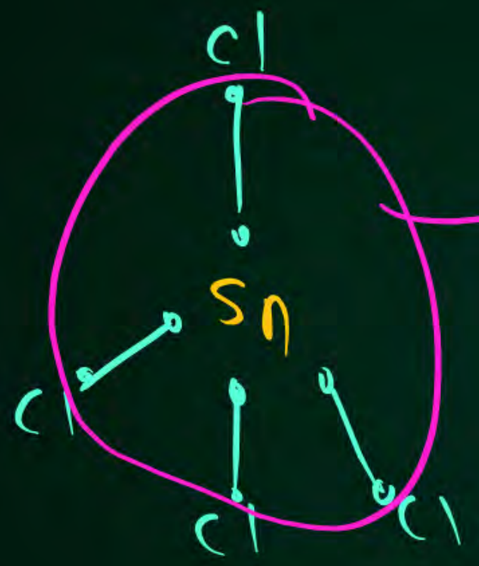
Al^{3+} $1s^2 \underbrace{2s^2 2p^6}_{8e^-}$

F^- $1s^2 \underbrace{2s^2 2p^6}_{8e^-}$

QUESTION

Which is not an exception to octet rule ?

1. BF_3 hypo.
2. $SnCl_4$
3. BeI_2 hypo.
4. PCl_5 hyper



8e⁻

octet complete

odd e^- Species :-

(i) NO

$7e^-$

(ii) NO_2

$7e^-$

Some more Ex. of odd e^- species :-

ClO_2

ClO_3

CH_3

CF_3

Some imp points

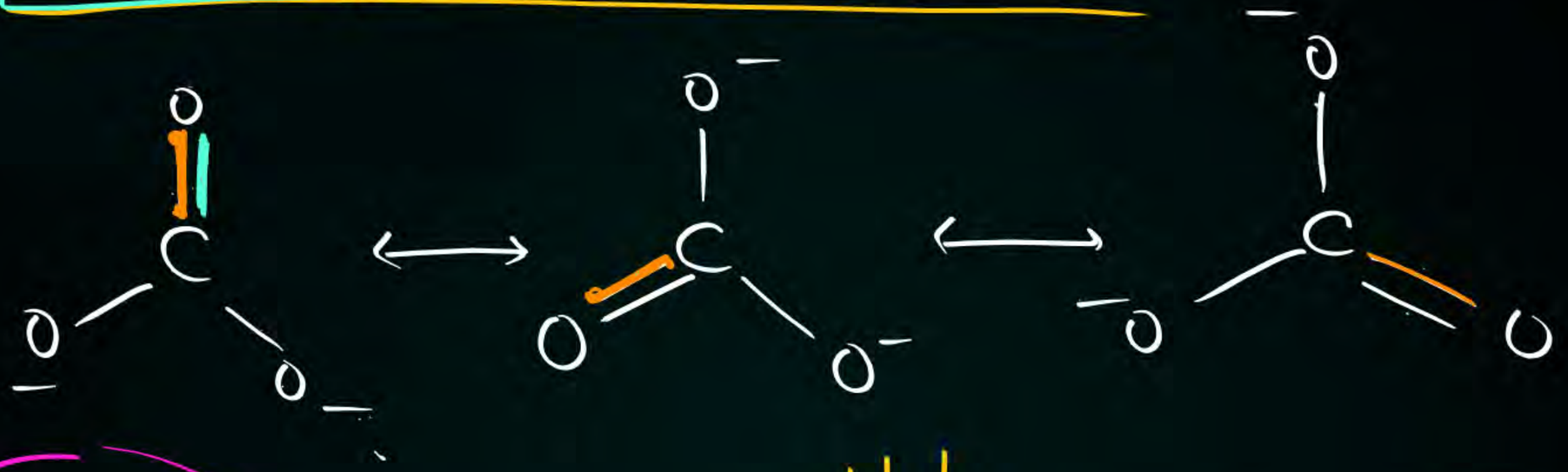
(i) Lewis Acid :- e^- pair Acceptor.
(e deficient Ex BF_3)
→ gen. hypovalent species

(ii) Lewis Base :- e^- pair donar
e^- Rich Compounds.

Ex NH_3

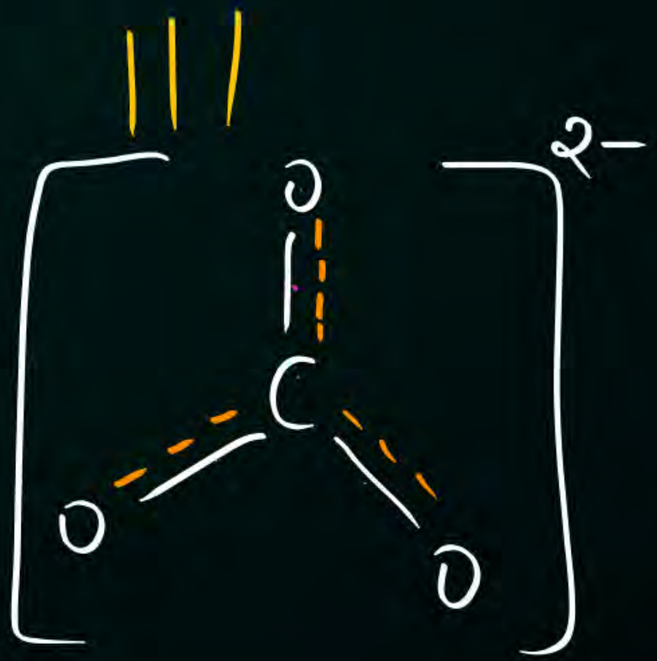
8 e^-
octet Complete
l.p available
Can work as
Lewis Base

Resonance in CO_3^{2-} (carbonate ion)



$\frac{4}{3} = 1.33$

Avg. F.C on oxygen $\frac{-2}{3}$



Avg Bond Order

$1 + \frac{1}{3} = 1.33$

Avg. Formal Charge & Avg. X-O Bond order in Oxo-anions :

surrounding atoms oxygen.

$$\text{Avg. F.C} = \frac{\text{Total Charge Present of oxygen atom}}{\text{Number of oxygen atom where negative charge can be placed}}$$

on oxygen

$$\text{Avg. X-O bond order} = \frac{\text{Total number of X-O bonds}}{\text{Number of X-O pairs participate in resonance}}$$

SO_4^{2-}

NO_3^-

NO_2^-

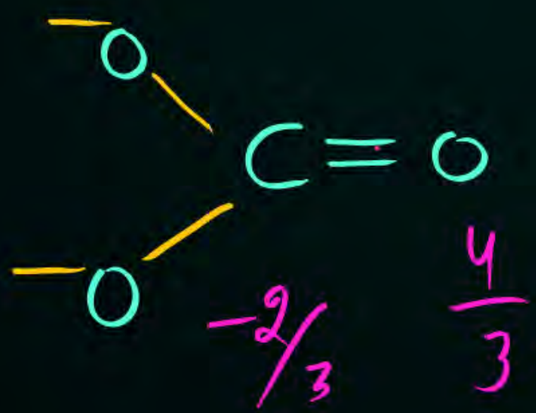
ClO_3^- SO_3^{2-}

ClO_4^-

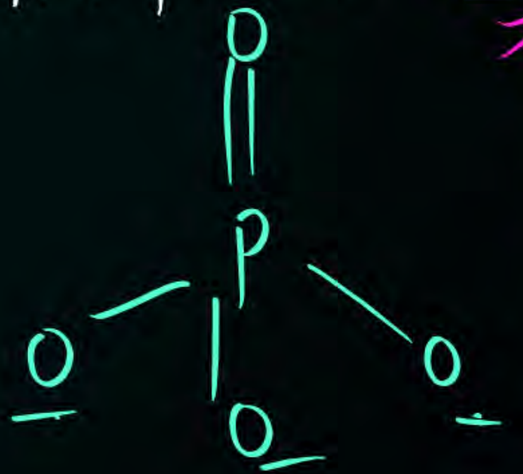
MDJ

	F.C
$-\ddot{O}$	-1
$=O$ or $-O-$	0
$\equiv O$ or $=O-$	$+1$

(i) CO_3^{2-}

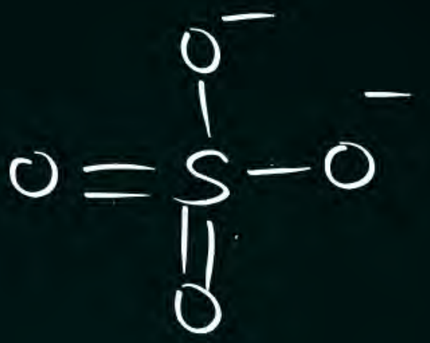
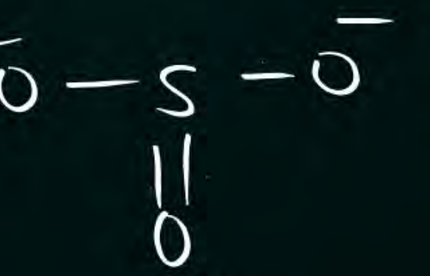
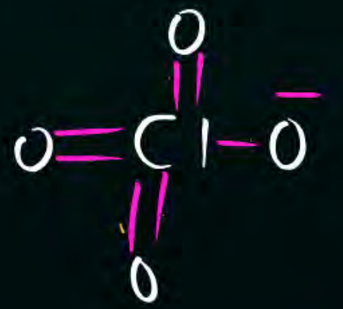


(ii) PO_4^{3-} phosphate.



$-3/4$ Avg F.C

5/4 Avg B.O

			Avg F.Con "O"	Avg B.O
(iii)	NO_2^- Nitrite ion		$-1/2$	$3/2$
(iv)	SO_4^{2-} Sulphate ion		$-2/4$	$6/4$
(v)	SO_3^{2-} Sulphite ion		$-2/3$	$4/3$
(vi)	ClO_4^- Perchlorate ion		$-1/4$	$7/4$

H.W ClO_3^-

ClO_2^-

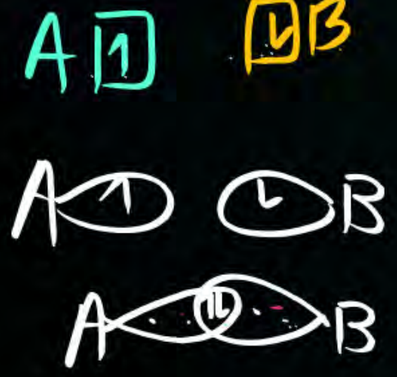
"Covalent Bond"

Sharing of e^-

Simple Covalent

Equal sharing

A — B



Coordinate Covalent Bond

Unequal sharing

A : → B

donor acceptor

A → B

or

A^+ — $\bar{B}$

① Coordinate covalent

② Covalency

③ Overlapping

Defination

* Merging of orbitals
* Mechanism of Covalent Bond Formation

Covalency

Combining Capacity of an atom in given covalent Compound.

MDJ No. of $\sigma + \pi$ Bonds.

Ex

Covalency of C $\Rightarrow$ 4

Ex

Covalency of C = 4

Covalency of H = 1

BF_3 Covalency of B = 3

Covalency of F = 1

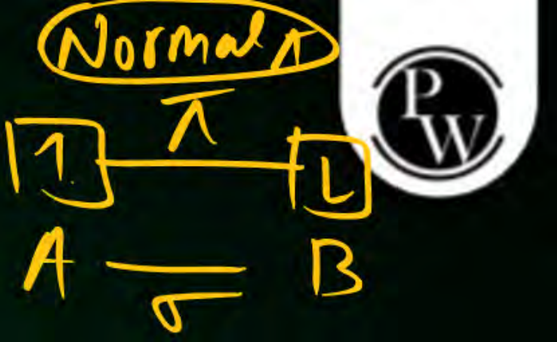
CO_2 O=C=O Covalency of C = 4

Covalency of O = 2

PCl_5 Covalency of P = 5

Covalency of Cl = 1

Coordinate Bond :



Formed by the unequal sharing of e^-.

Coordinate bond is formed b/w e^- donor & e^- acceptor.

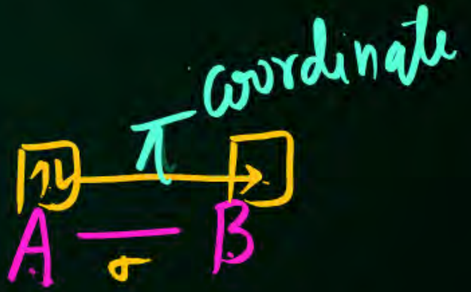
It can not be distinguish from covalent bond after formation.

Coordinate Bond

- σ Coordinate Included in covalency

A → B
σ Coordinate

- π coordinate weak Bond (Back Bond) Not included in Covalency



A ⟹ B

⇒ Species having σ Coordinate / Dative Bond

1. PH_4^+
2. NH_4^+
3. $NH_3 \cdot BF_3$
4. PCl_6^-
5. BF_4^-
6. O_3
7. NO_2
8. NO_3^-
9. H_3O^+
16. BH_4^-
11. $AlCl_4^-$

and all Complex Compounds or Coordination Compounds

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FOR NEET 2025

Lecture - 03 | Inorganic Chemistry

Chemical Bonding And Molecular Structure

By - Mohit Dadheech (MD Sir)

Topics *to be covered*

1. Covalent Bond, Coordinate Bond
2. Covalency of B, N, P

Covalent Bond :

"Bond formed by the equal sharing of e^-"

Covalency : "Total number of covalent bond (σ & π) formed by an atom in a molecule".

NOTE : Maximum covalency of second period element can not be more than 4 due to absence of d-orbitals.

Li	Be	B	C	N	O	F
$2s^1$	$2s^2$	$2s^2 2p^1$				

$1s^2 \; 2s^2 \; 2p$

↓ valence shell = (2)

$n = 2$

$l = ?$

$(l = 0 \text{ to } n-1)$

$l = 0, 1$

$s \quad p$

For 2nd period

Valence shell

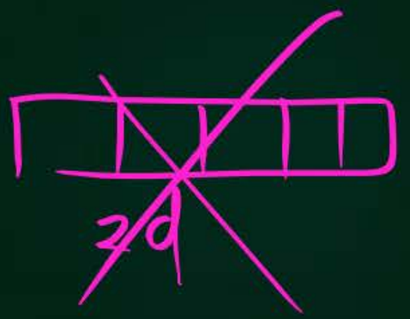
(MDJ)

2nd period Vale 4 se Jyada Bond nahi Banaskate.

(A)

∴ 4 orbitals present

So maximum Four Bonds Can be formed



O & F Can not show 4 Covalency.

F → always one.

O → gen 1 & 2

(NOTE) → [All 2nd period elements have max Four Covalency (F)]

max Covalency of 2nd period element can be four (T)

$n=3$ → 3rd period

$l = 0, 1, 2$

s, p, d

Valence shell

Na: $[Ne]\,3s^1\,3p^0\,3d^0$ Mg: $[Ne]\,3s^2\,3p^0\,3d^0$ Al: $3s^2\,3p^1\,3d^0$ Si P S Cl

$3d^0$

Vacant 3d orbitals are present in valence shell.

Vacant 3d orbitals are available for bonding.

So 3rd period element can extend their covalency beyond four.

QUESTION

Which of the following species do not exist :

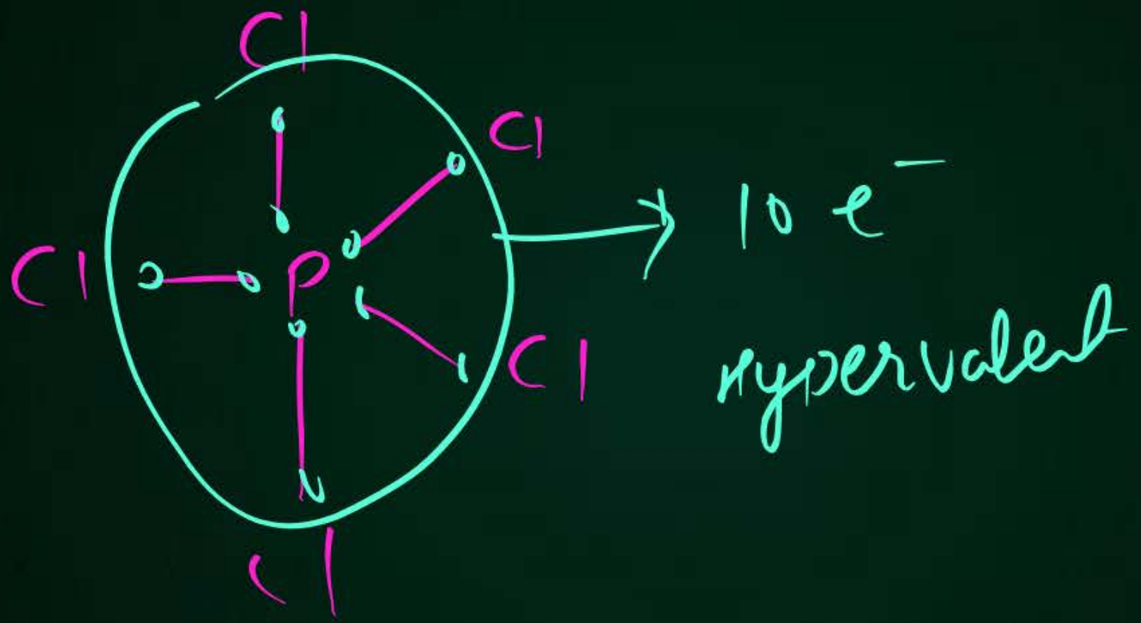
1. BF_6^{3-} (B → 2nd period)
2. SiF_6^{2-} (Si)
3. PCl_6^- (P)
4. AlF_6^{3-} (Al)

(2, 3, 4 → 3rd Period)

QUESTION

Which of the following species does not obey octet rule ?

1. SiF_4
2. PCl_5
3. ICl_2^+
4. BF_4^-



Covalency of B

(B) $1s^2 2s^2 2p^1$

(1)

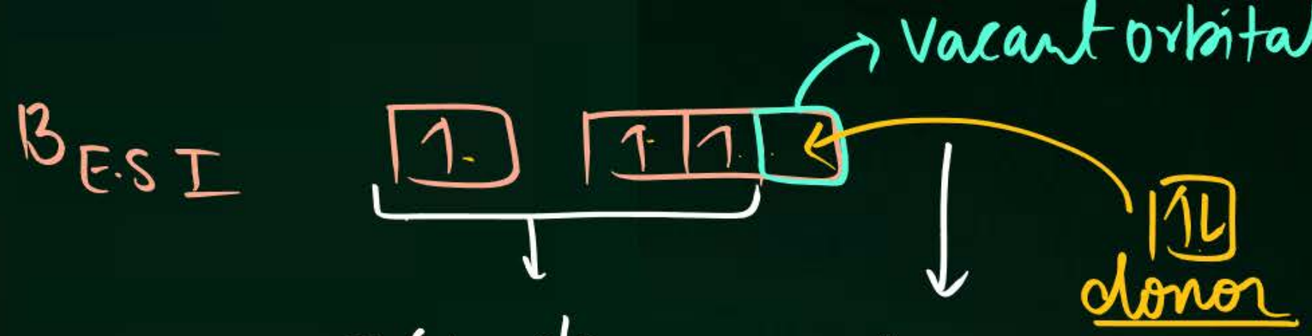
$B_{G.S}$

$B_{E.S-I}$

3 Bonds
equalsharing $\Rightarrow$ Covalency $= 3$

(Ex) BF_3, BCl_3, BBr_3

$B(OH)_3$
or
H_3BO_3



Covalency = 4 Ex BH_4^-, BF_4^-, $B(OH)_4^-$

l.p acceptor

✓ Lewis Acid

Normal covalency of (B) is three But it can be four in presence of 1 σ Coordinate Bond.

Covalency of N

$1s^2 2s^2 2p^3$

H 1s¹ ↑

H^+ 1s ☐

$N_{G.S}$ ↑↓ ↑ ↑ ↑

3 Covalency

NH_3, NF_3, NCl_3, NBr_3 etc

acceptor

Vacant orbital

Lewis Base

donor

↑↓ ↑ ↑ ↑

1 σ coordinate by donating l.p

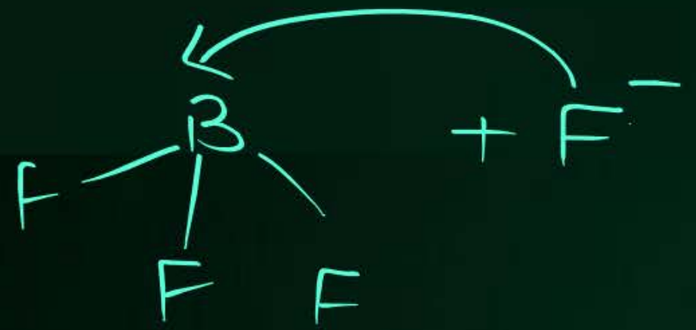
3 simple Covalent

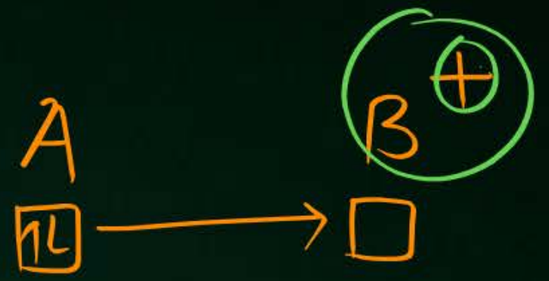
Covalency 4

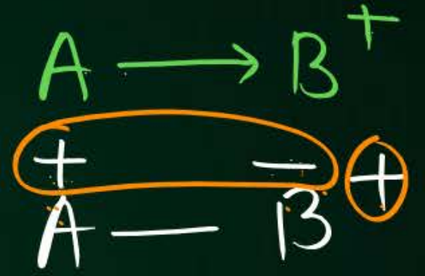
Ex NH_4^+

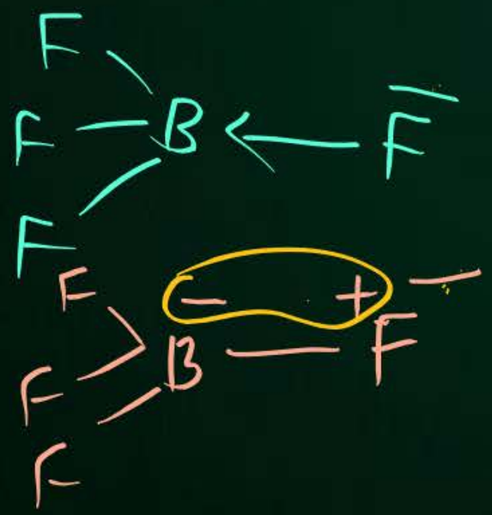
Ex ↑↓ ↑ ↑ ↑ + H^+ → NH_4^+ ammonium ion.

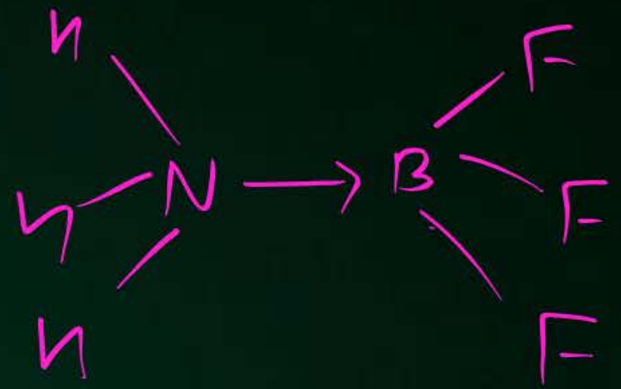
L.B

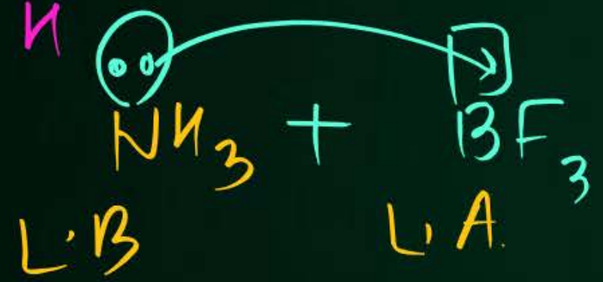

B
F
F
F
+ F −


A
B +


A → B +
A — B +


F
F
F
B
F
F
F
B
F
F
F





$$NH_3 + BF_3 \longrightarrow H_3N \longrightarrow BF_3$$

L·B L·A

$$H_3N^{+}—\overline{B}F_3$$

Covalency of (P) 3rd period

$[Ne]\ 3s^2\ 3p^3\ 3d^0$

$P_{G.S}$

Covalency = 3

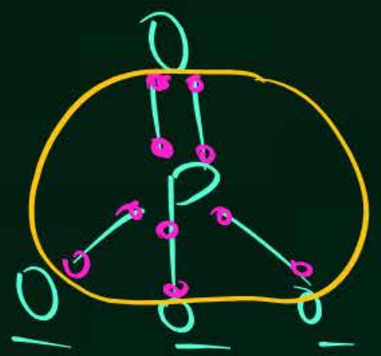
Ex PCl_3, PH_3, PF_3 etc.

$P_{E.S-I}$

5 covalency

Ex PCl_5, PBr_5, PF_5

PO_4^{3-}



10 e^-

Hypervalent

$(8+8+8+8+8) - (5+6\times4+3)$

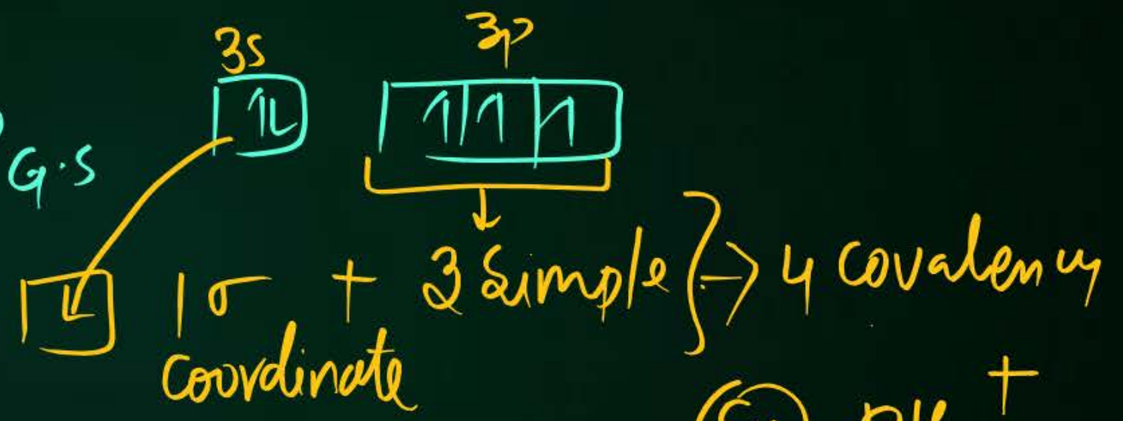
$40 - 32$

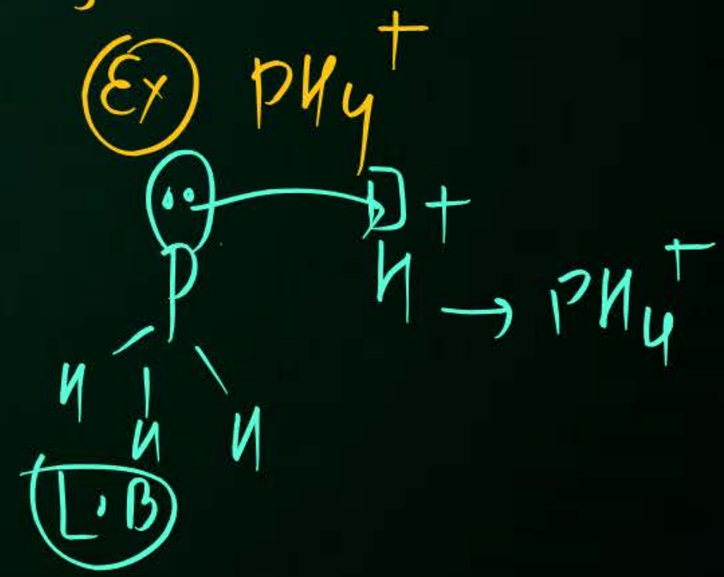
$\frac{40-32}{2} = \frac{8}{2} = 4$

Normal Covalency of P is 3 & 5

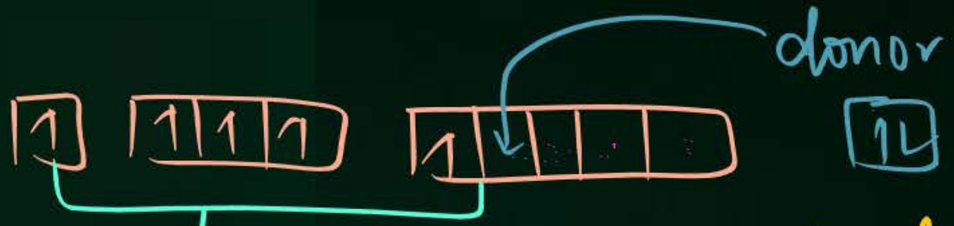
But it can be (four) & (six) in presence of σ Coordinate Bonds

Four Covalency





$P_{E.S-I}$



5 simple Covalent + 1 σ Coordinate By accepting l.p

Covalency = 6

(Ex) $PCl_5 + Cl^- \longrightarrow PCl_6^-$

$PCl_5 + Cl^-$

QUESTION

Which of the following species can behave as Lewis Base ?

l.p donar

1. BF_3
2. CCl_4
3. NH_4^+
4. PH_3 ✓

QUESTION

Which trihalide ion is unknown due to absence of vacant d-orbital ?

1. F_3^-

2. Br_3^-

3. I_3^-

4. Cl_3^-

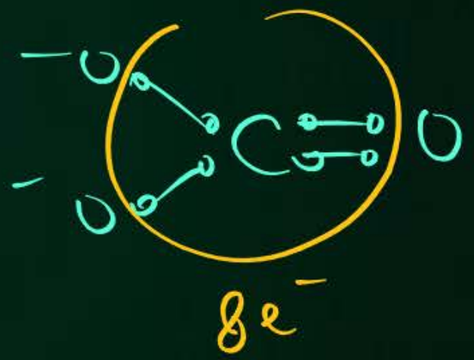
QUESTION

Which of the following species are hypervalent ?

(I) ClO_4^- (II) BF_3 (III) SO_4^{2-} (IV) CO_3^{2-}

Hyper Hypo Hyper 8e⁻ octet ✓

1. I, II, III
2. I, III ✓
3. III, IV
4. I, III, IV



QUESTION

Incorrect statement about nitrogen is :

1. General covalency = 3
2. Maximum covalency = 4
3. Maximum oxidation state = +5
4. None of these

$(+5)$ NO_3^-, N_2O_5,

Homework

(1) ↳ show, 2, 4, & 6 Covalency of S

(2) show 1, 3, 5, 7 Covalency of Cl

(3) show 2, 4, 6 Covalency of Xe.

(4) In which E.S of Xe, Compound XeF_6 will be Formed?

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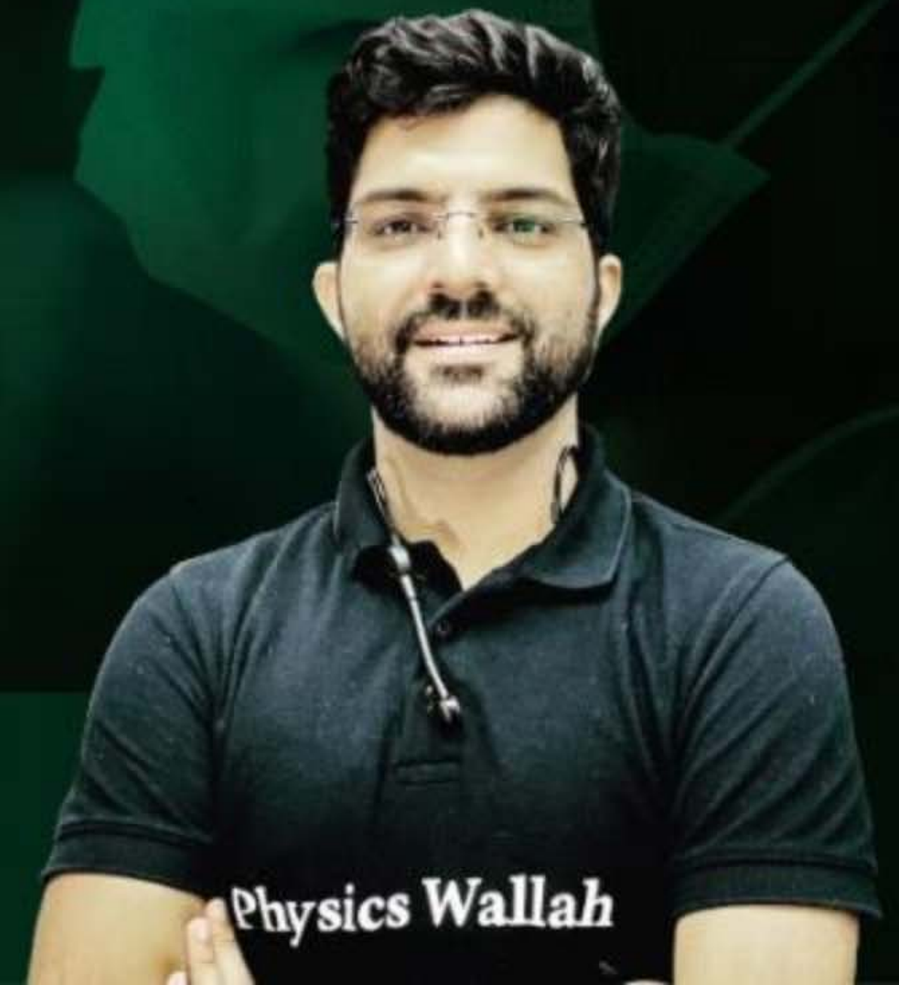
Lecture - 04 | Inorganic Chemistry

Chemical Bonding & Molecular Structure



By - Mohit Dadheech (MD Sir)

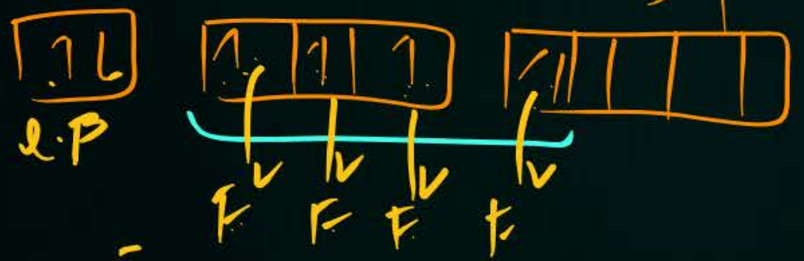
Topics *to be covered*

1. VSEPR Theory (Shape/Geometry of Molecules)

H.W (5)

$3s^2\ 3p^4\ 3d^0$

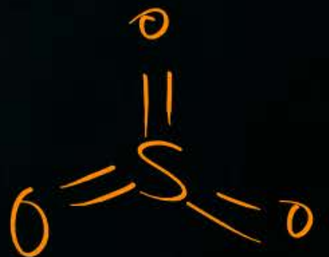
$S_{G.S}$ Covalency = 2 Ex SF_2

$S_{E.S-I}$ 

Covalency = 4 Ex SF_4

$S_{E.S-II}$ Covalency = 6

SF_6 , SO_3



H.W Ans

Cl $3s^2 3p^5$

Ex

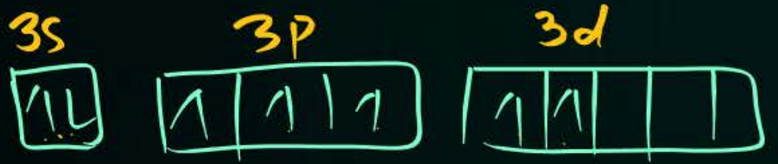
ClF Covalency = 1

$Cl_{G.S}$

$Cl_{E.S-I}$

Covalency = 3 ClF_3

$Cl_{E.S-II}$

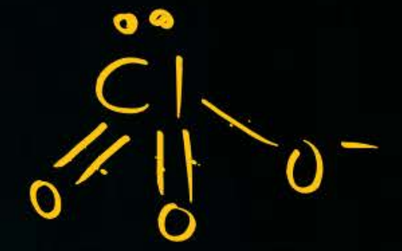


Covalency = 5 ClO_3^-

$Cl_{E.S-III}$

Covalency = 7 ClO_4^-

chlorate ion



Xe $5s^2 5p^6 5d^0$

G.S ↑↓ | ↑↓ | ↑↓ | ↑ | ↑ Covalency = 0

E.S-I ↑↓ | ↑↓ | ↑ | ↑ | ↑ | ↑ Covalency = 2 XeF_2

E.S=II ↑↓ | ↑↓ | ↑ | ↑ | ↑ | ↑ | ↑ Covalency = 4 XeF_4

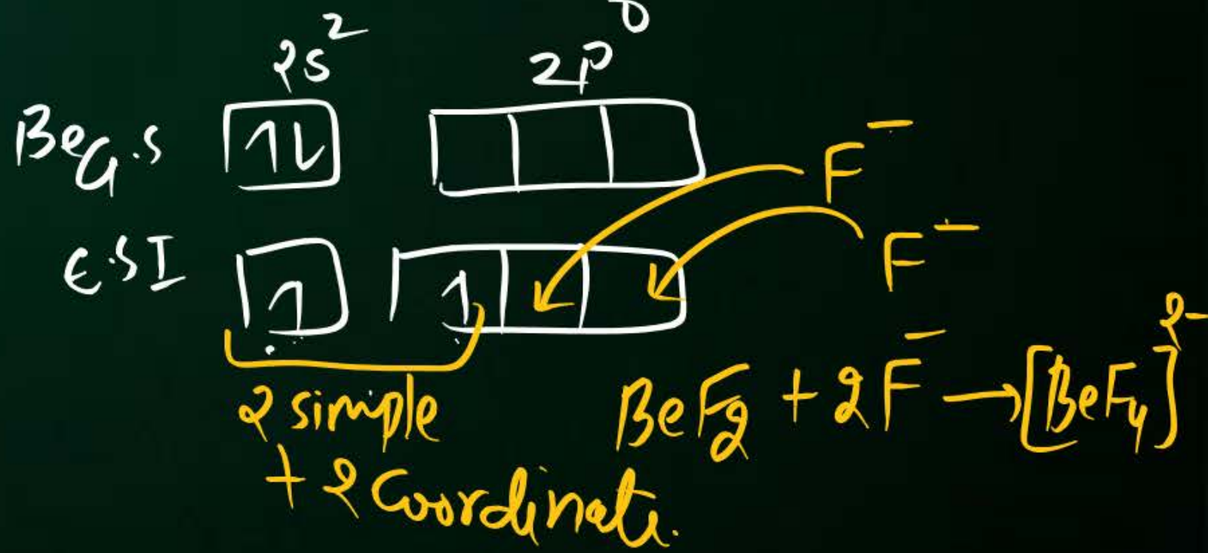
E.S=III ↑↓ | ↑ | ↑ | ↑ | ↑ | ↑ | ↑ | ↑ | ↑ Covalency = 6 XeF_6

XeO_3

QUESTION

Which of the following is not correctly matched ?

1. ClF_3 excited state I of Cl ✓
2. XeO_2F_2 excited state II of Xe ✗
3. BeF_4^{-2} excited state I of Be ✓
4. SF_6 excited state II of S ✓

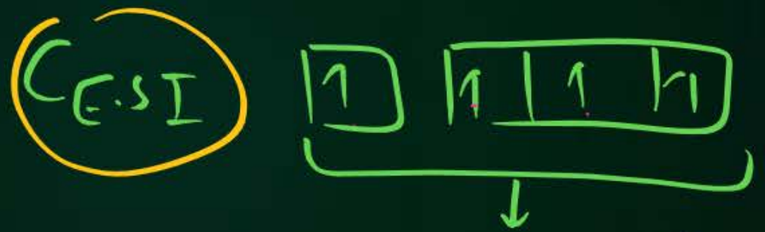


QUESTION

In which of the following molecule electron of 2s in carbon is not promoted to 2p sub shell ?

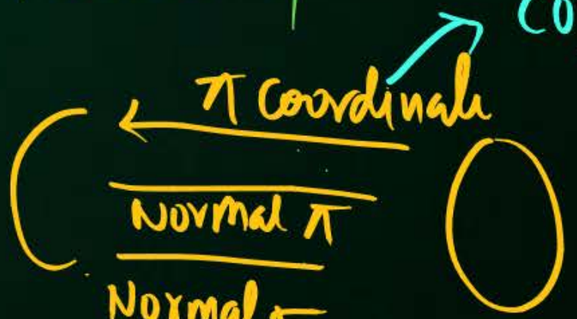
1. HCN

2. CO_2



3. CS_2

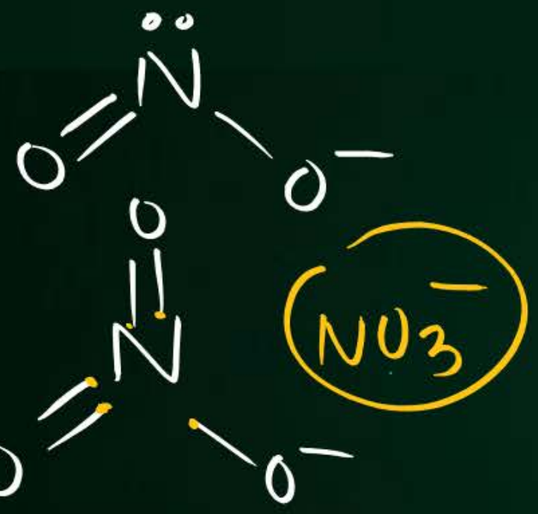
4. CO ✓



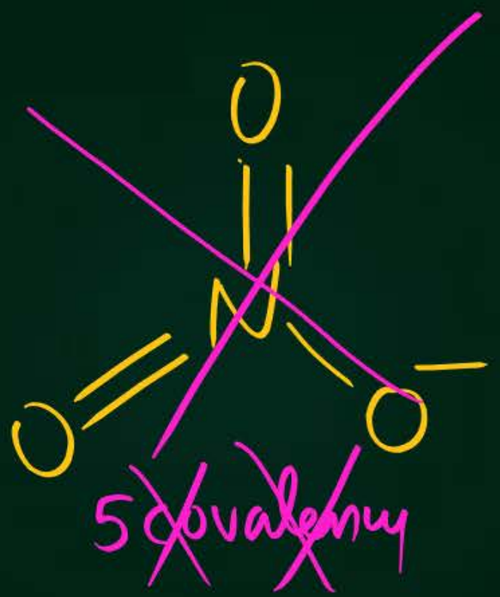
W.O.F Compound of "N" is not possible :-

(1) $\ddot{N}Cl_3$

(2)



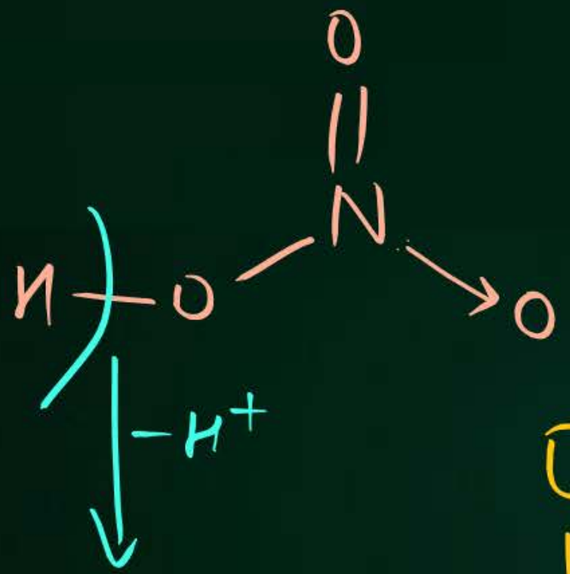
(3)

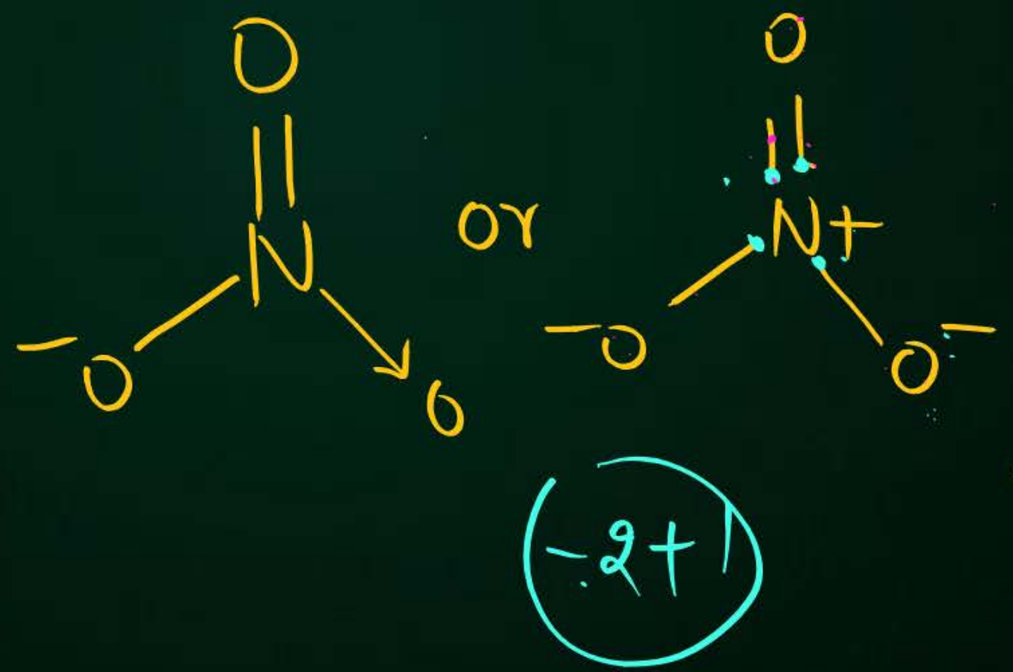


NO_3^-

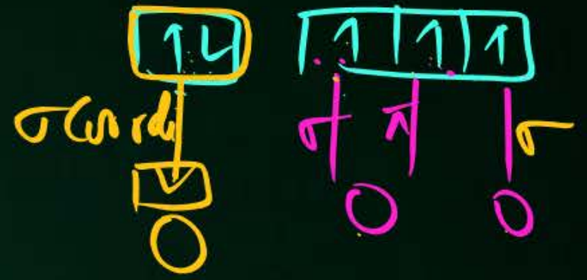
(4) $\ddot{N}H_3$

HNO_3





(N) $2s^2 2p^3$



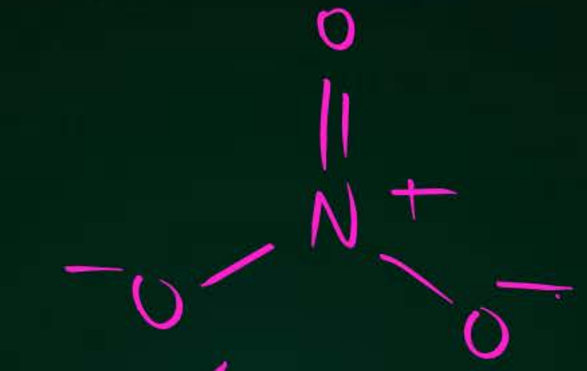
Avg F.C on "O" $= -\frac{2}{3}$

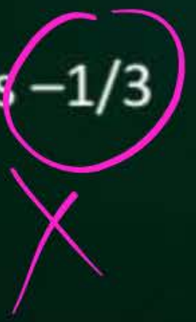
Avg N-O B.O $= \frac{4}{3}$

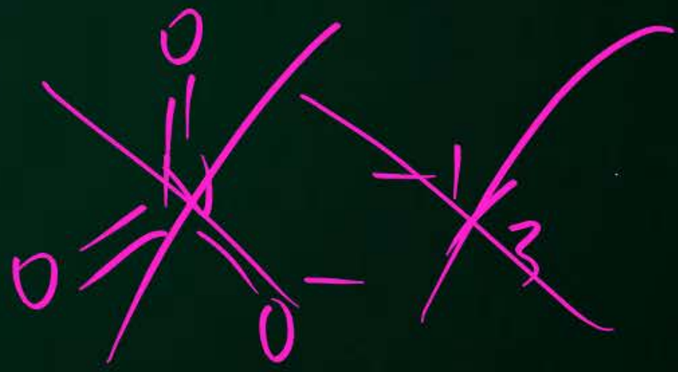
QUESTION

Which is incorrect for NO_3^-

1. Formal charge on N is +1
2. 4 bond pair and 0 lone pair at N
3. Average F.C. on Oxygen atom is –1/3
4. None of these







VSEPR (Valence Shell Electron Pair Repulsion Theory) :

(B.P & L.P)

- It is based on the repulsive interactions of the electron pairs in the valence shell of the atoms.

- According to VSEPR every molecule has a tendency to acquire certain geometrical shape in which repulsion between various e^- pairs is minimized & thus maximize distance between them.

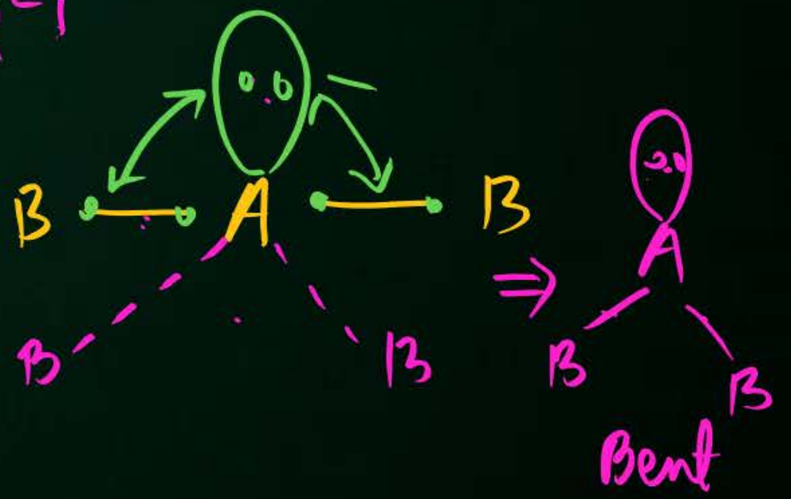
AB_2L_0

B — A — B

$\theta = 180°$

linear.

AB_2L_1



VSEPR (Valence Shell Electron Pair Repulsion Theory) :

Order of Repulsion b/w various e⁻ pairs :-

$$l.p - l.p > l.p - b.p > b.p - b.p$$

(Note) l.p aquire more avg space on central atom.

NOTE

Overall geometry/shape of Molecule is depend on number of σ Bond pairs & lone pairs

linear

Type of Monocentric Molecules (AB_nL_m)

In Which l.p is "Not present"

- AB_2L_0 → linear ✓
- AB_3L_0 → Triangular planar ✓
- AB_4L_0 → Tetrahedral
- AB_5L_0 → Triangular bipyramidal (TBP)
- AB_6L_0 → Square Bipyramidal/octahedral (SBP)
- AB_7L_0 → Pentagonal Bipyramidal (PBP)

In which l.p is present.

- AB_2L_1 → Bent/Angular/V-shape
- AB_3L_1 → Triangular Pyramidal
- AB_2L_2 → Bent/Angular/V-shape
- AB_4L_1 → See-saw
- AB_3L_2 → Bent-T shape
- AB_2L_3 → linear
- AB_5L_1 → Square pyramidal
- AB_4L_2 → square planar
- AB_6L_1 → distorted octahedral
- AB_5L_2 → Pentagonal Planar

Trick to find n & m in AB_nL_m :

AB_nL_m

A = Central atom

B = σ bond pair = no. of surrounding atoms

L = Lone pair

n = Number of σ bond pair

m = Number of lone pair

$$= \frac{\text{Total Valence } e^-}{8}$$

Quotient = n

Remainder / 2 = m

(Note) If there is −ve or +ve charge present in species then add or subtract e^- accordingly in Valence e^-

❖ Do not apply this trick for odd electron species & species having hydrogen as surrounding atom.

1. CO_2 $\frac{4+6+6}{8} = \frac{16}{8} = Q=2$ $R=0$ AB_2L_0 linear sp

2. SO_3 $\frac{6+6+6+6}{8} = \frac{24}{8} = Q=3$ $R=0$ AB_3L_0 T. planar. sp^2

3. SO_2 $\frac{6+6+6}{8} = \frac{18}{8}$ $Q=2$ $R/2 = 2/2 = 1$ AB_2L_1 Bent sp^2

8) 18 (2 ⇒ Q
16
2 ⇒ R
$R/2 = 2/2 = 1$

(4.) PCl_3

$$\frac{5+7+7+7}{8} = \frac{26}{8}$$

$Q = (3)$

$R = 2$ $\quad \frac{R}{2} = (1)$

AB_3L_1 T. Pyramidal

sp^3

(5) SO_4^{2-}

$$\frac{6+6+6+6+6+2}{8} = \frac{32}{8}$$

$Q = 4$

$R = 0$

AB_4L_0 Tetrahedral

sp^3

(6) NO_2^+

$$\frac{5+6+6-1}{8} = \frac{16}{8} \quad \begin{matrix} \Phi = 2 \\ R = 0 \end{matrix} \quad AB_2L_0 \text{ linear}$$

sp

MDJ

When surrounding atoms are Hydrogen.

no. of σ Bonds = no. of Hydrogen atoms

$$\text{no. of lone pair} = \frac{\text{Valence}^- \text{ of C.A}}{2} - \text{no. of Hydrogens}$$

CH_4

Val e$^-$ = 4

$= \frac{4-4}{2} = 0$

AB_4L_0

sp^3 Tetrahedral.

NH_2^-

$\frac{(5+1)-2}{2} \quad \frac{4}{2} = 2$

no. of l.p.

AB_2L_2

Bent sp^3

(3) NH_3 $\frac{5-3}{2} = \frac{2}{2} = 1$ (l.p)

AB_3L_1 T. Pyramidal sp^3

(4) NH_4^+ $(5-1)$

$\frac{4-4}{2} = 0$

AB_4L_0 Tetrahedral

sp^3

⇒ XeO_2F_2 $\quad \frac{8+6+6+7+7}{8} = \frac{34}{8}$ $\quad Q = 4$

$R = 2$ $\quad \frac{R}{2} = 1$

AB_4L_1 See saw

sp^3d

How to find Hybridisation :

Super duper MDJ

Number of H. O. (L.P. + σ) (AB_nL_m) $(m+n)$		Type of Hybridisation
2	→	sp $s+p$
3	→	sp^2 $s+p+p$
4	→	sp^3 $s+p+p+p$
5	→	sp^3d $s+p+p+p+d$
6	→	sp^3d^2 $s+p+p+p+d+d$
7	→	sp^3d^3 $s+p+p+p+d+d+d$

QUESTION

& Type of Hybridization

Give the correct name of shape of following compounds –

1.	PCl_5 AB_5L_0 sp^3d	11.	$AlCl_3$	21.	BrF_5
2.	SF_6	12.	$BeCl_2$	22.	BrF_3
3.	SO_2	13.	SF_4	23.	I_3^-
4.	SO_3	14.	SF_2	24.	ICl_2^-
* 5.	NH_4^+	15.	XeO_4	25.	I_3^+
* 6.	H_2O	16.	XeO_3	26.	ICl_2^+
* 7.	H_3O^+	17.	XeF_6	27.	PCl_4^+
8.	BF_3	18.	XeF_4	*28.	BH_4^-
9.	BF_4^-	19.	XeF_2	29.	NO_3^-
10.	PCl_6^-	20.	ClF_3		

QUESTION

Which of the following molecules has trigonal planar geometry :

1. NH_3
2. BF_3
3. PCl_3
4. IF_3

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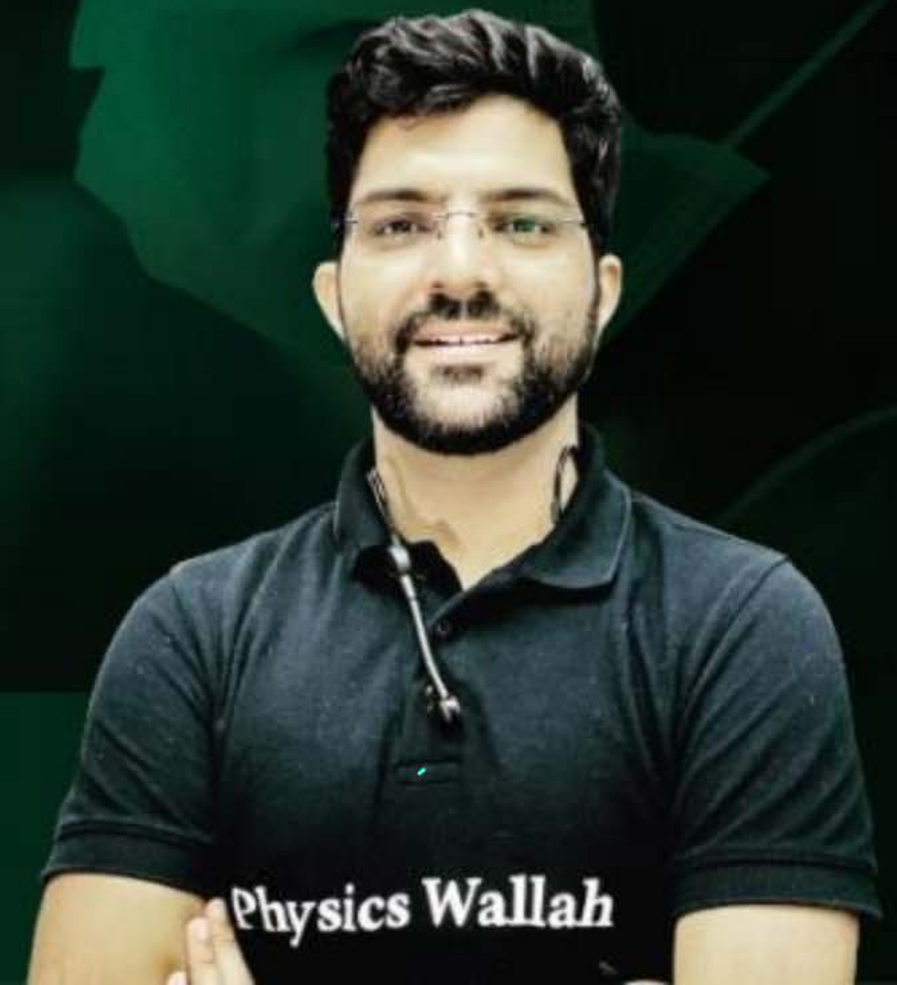
YAKEEN 2.0

FOR NEET 2025

Lecture - 05 | Inorganic Chemistry

Chemical Bonding & Molecular Structure



By - Mohit Dadheech (MD Sir)

Topics *to be covered*

1. VSEPR Theory (Shape/Geometry of Molecules) (Part-II)

QUESTION

Home work Ans.

Give the correct name of shape of following compounds –

1. PCl_5 AB_5L_0 sp^3d
2. SF_6 AB_6L_0 sp^3d^2
3. SO_2 AB_2L_1 sp^2
4. SO_3 AB_3L_0 sp^2
5. NH_4^+ AB_4L_0 sp^3
6. H_2O AB_2L_2 sp^3
7. H_3O^+ AB_3L_1 sp^3
8. BF_3 AB_3L_0 sp^2
9. BF_4^- AB_4L_0 sp^3
10. PCl_6^- AB_6L_0 sp^3d^2
11. $AlCl_3$ AB_3L_0 sp^2
12. $BeCl_2$ AB_2L_0 sp
13. SF_4 AB_4L_1 sp^3d
14. SF_2 AB_2L_2 sp^3
15. XeO_4 AB_4L_0 sp^3
16. XeO_3 AB_3L_1 sp^3
17. XeF_6 AB_6L_1 sp^3d^3
18. XeF_4 AB_4L_2 sp^3d^2
19. XeF_2 AB_2L_3 sp^3d
20. ClF_3 AB_3L_2 sp^3d
21. BrF_5 AB_5L_1 sp^3d^2
22. BrF_3 AB_3L_2 sp^3d
23. I_3^- AB_2L_3 sp^3d
24. ICl_2^- AB_2L_3 sp^3d
25. I_3^+ AB_2L_2 sp^3
26. ICl_2^+ AB_2L_2 sp^3
27. PCl_4^+ AB_4L_0 sp^3
28. BH_4^- AB_4L_0 sp^3
29. NO_3^- AB_3L_0 sp^2

H_2O AB_2L_2 Bent sp^3

$6-2=4$ $\frac{4}{2}=2$ L.P

H_3O^+ $(6-1)=5$ $\frac{5-3}{2}=1$

AB_3L_1 sp^3 T. Pyramidal.

I_3^- $\frac{7+7+7+1}{8}$ $\frac{22}{8}$ $Q=2$ AB_2L_3 linear

$R=6$

$R/2=3$

MD 'J

Jab Surrounding Mai Halogen No to Hydrogen wala. Jugaad lagen do.

XeF_4

$\frac{8-4}{2} = 2$ l.p

AB_4L_2

BrF_5 $\quad \frac{7-5}{2} = 1$

AB_5L_1

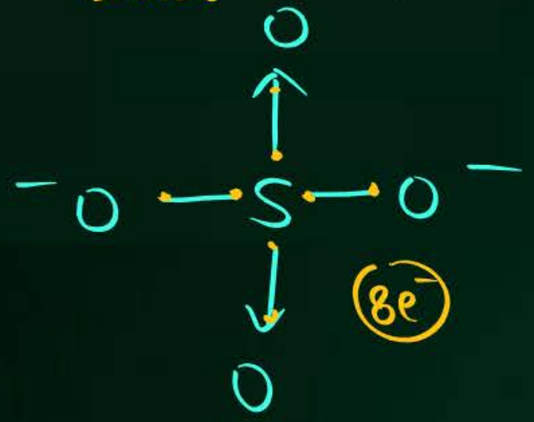
PCl_4^+ $\quad AB_4L_0$

sp3

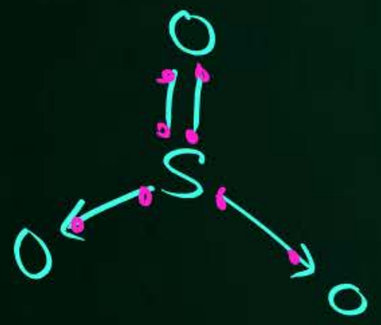
Old structure

Based on Octet Rule.

SO_4^{2-}



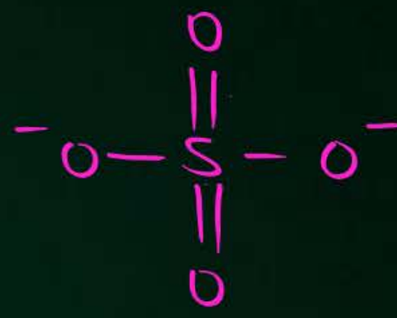
SO_3



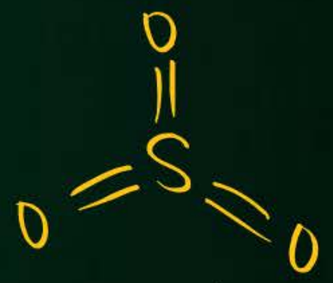
SO_2

New Structure

Based on Modern Concept



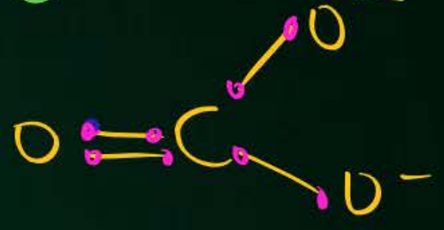
Hypervalent.



W.O.F Molecule does not have dative Bond (coordinate)

(1) CO

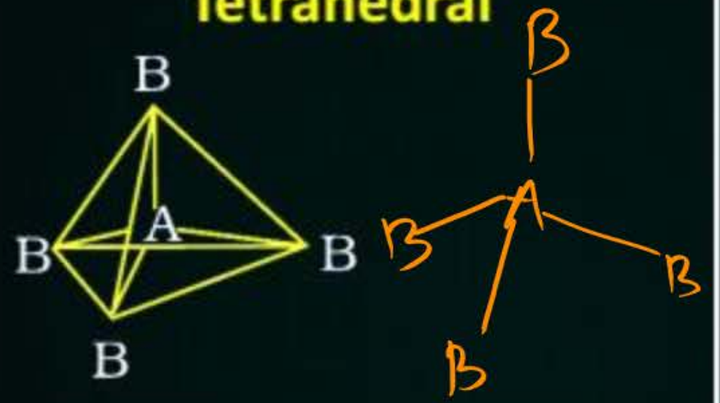
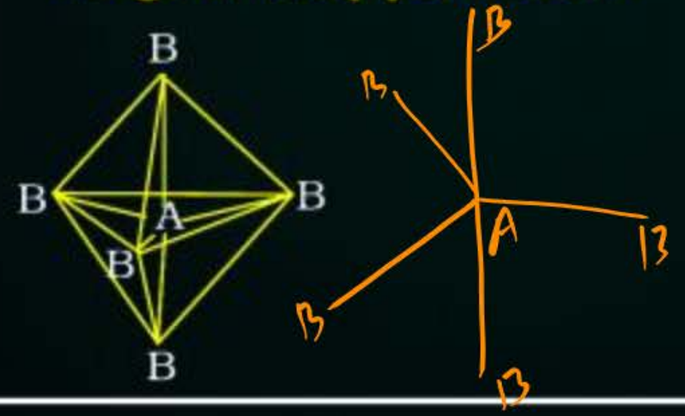
(2) CO_3^{2-}



(3) SO_4^{2-} old structure

(4) All of these

Molecule Type	Shape/Molecular Geometry	Remarks
AB_2L_0	**Linear** **B – A – B**	$\theta = 180°$ ✓ Planar structure Imp. Ex. : $BeCl_2$, CO_2, NO_2^+ $HgCl_2$
AB_3L_0	**Trigonal Planar** 	$\theta = 120°$(Three) ✓ Planar structure Imp. Ex. : BF_3, BCl_3, SO_3 etc.

Molecule Type	Shape/Molecular Geometry	Remarks
AB_4L_0	**Tetrahedral** 	θ = 109.5° or 109° 28′ (Six) Non-planar structure Imp. Ex. : CH_4, BF_4^-, NH_4^+ etc.
AB_5L_0	**Trigonal Bipyramidal** 	Non-planar structure ✓ Different angles are present ✓ Axial angle θ = 90° (Six) Equatorial angle θ = 120°(Three) Axial θ < Equ. θ All bond lengths are not same → axial B·L > eq B·L Imp. Ex. : PCl_5 * S·A must be same

Q In CH_4 Molecule How many H-C-H Angles are present

(1) 4

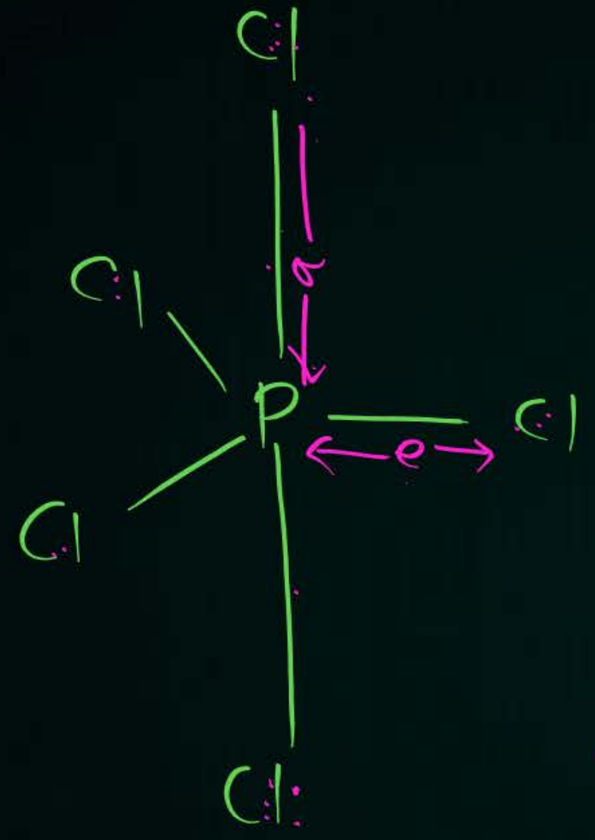
(2) 2

(3) 6

(4) 3

CH_4 AB_4L_0

Tetra



$a \Rightarrow$ axial B.L

$e \Rightarrow$ eq. B.L

$a > e$

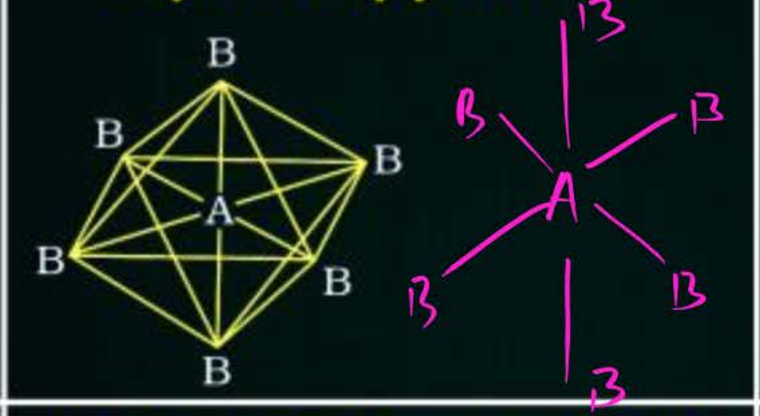
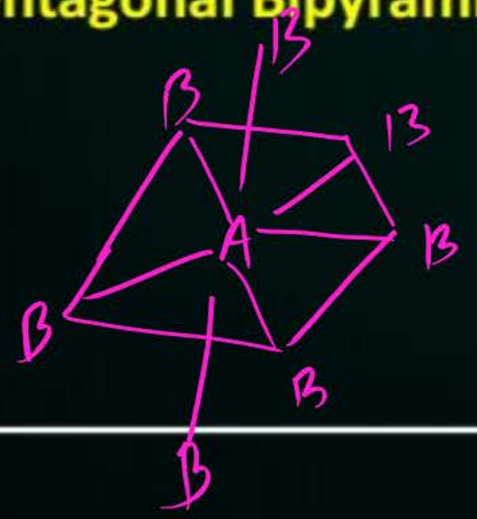
$\therefore a < e$

Bond length.

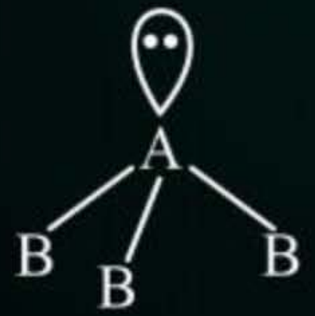
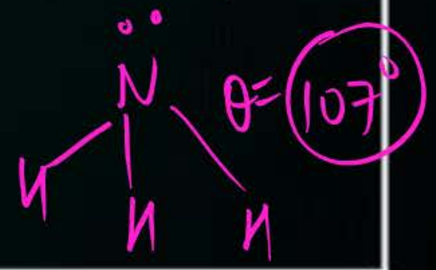
Bond angle

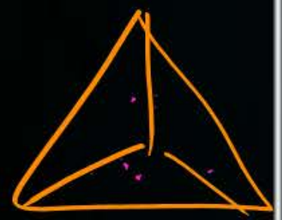
$$PCl_5 \xrightarrow{\Delta} PCl_3 + Cl_2$$

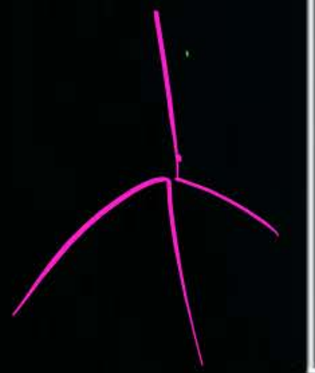
axial P–Cl B.L $>$ eq. P–Cl B.L

Molecule Type	Shape/Molecular Geometry	Remarks
AB_6L_0	**Square Bipyramidal** 	Non-planar structure ✓ Also known as octahedral ✓ Axial θ = Equ. θ ✓ Axial θ = 90° (Eight) ✓ Equa. θ = 90° (Four) ✓ } Total (12) Imp. Ex : SF_6, PCl_6^- etc. θ = 180° (Thike)
AB_7L_0	**Pentagonal Bipyramidal** 	Non-planar structure ✓ Axial θ > Equ. θ Axial θ = 90° (Ten) ✓ Equa. θ = 72° (Five) ✓ Imp. Ex : IF_7

(without l.p)

Molecule Type	Shape/Molecular Geometry	Remarks
AB_2L_1	**Bent / V shape** / Angular	$\theta < 120°$ Planar structure Imp. Ex. : SO_2, NO_2^-, O_3 etc.
AB_3L_1	**Trigonal Pyramidal** 	$\theta < 109.5°$ ✓ Non-planar structure ✓ Imp. Ex. : NH_3 





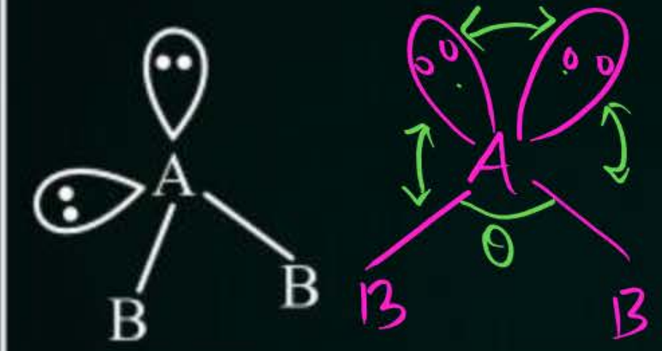
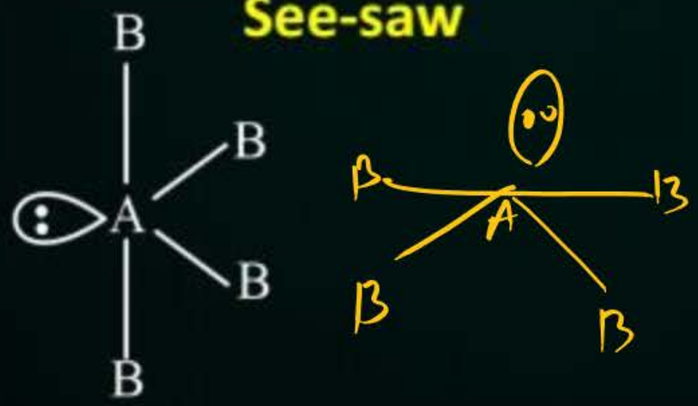
O_3

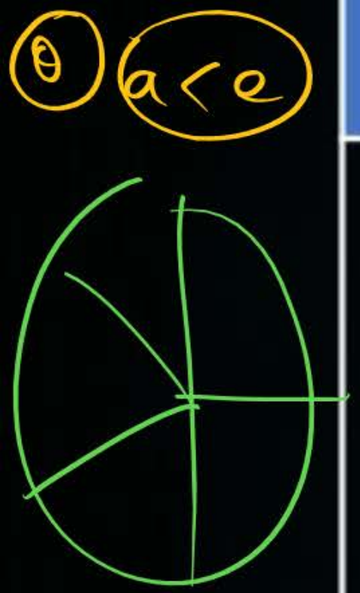
$\frac{18}{8}$ $Q = 2$

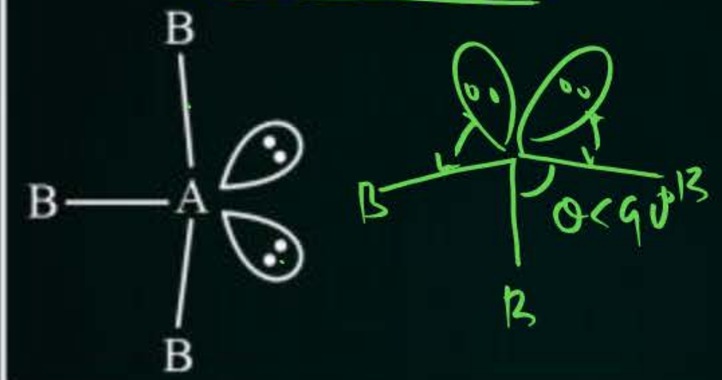
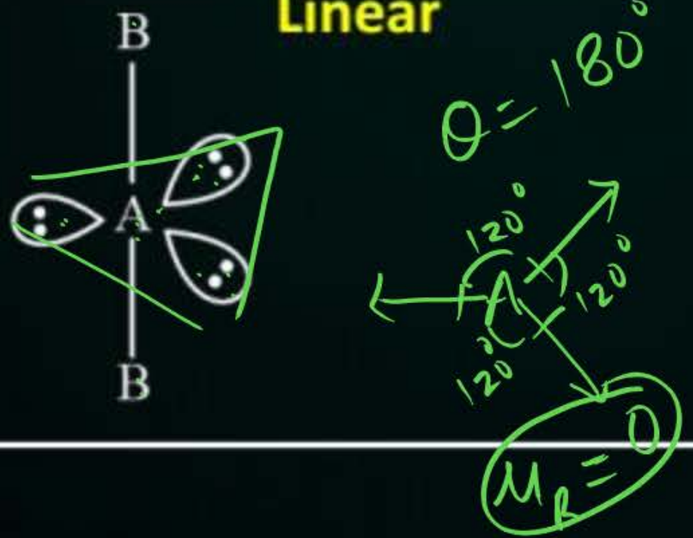
$R = 2$

$\frac{R}{2} = 1$

AB_2L_1

Molecule Type	Shape/Molecular Geometry	Remarks
AB_2L_2	**Bent / V shape** 	$\theta < 109.5°$ Planar structure Isostructural with AB_2L_1 Imp. Ex. : H_2O, SF_2 etc. $\theta = 104.5°$
AB_4L_1	**See-saw** 	Non-planar structure Imp. Ex. : SF_4 l.p occupy equatorial position.



Molecule Type	Shape/Molecular Geometry	Remarks
AB_3L_2	**Bent T shape** 	Planar structure ✓ Imp. Ex. : ClF_3, BrF_3
AB_2L_3	**Linear** 	Planar structure Isostructural with AB_2L_0 ✓ Imp. Ex. : XeF_2, I_3^- etc.

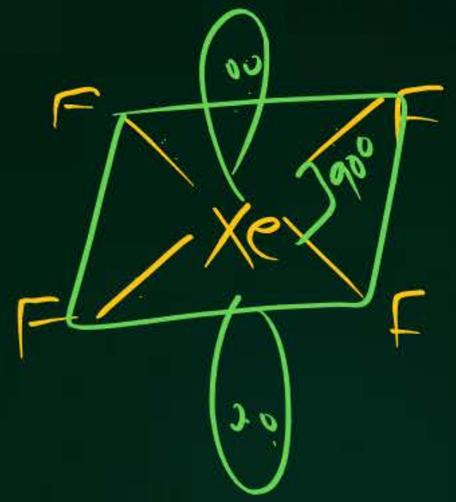
a=e

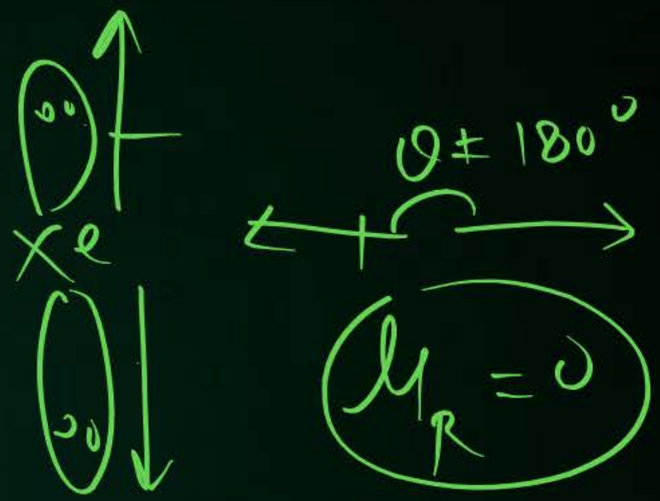
θ

Molecule Type	Shape/Molecular Geometry	Remarks
AB_5L_1	**Square Pyramidal**	Non-planar structure Imp. Ex. : BrF_5 l·p at any position ∵ a=e
AB_4L_2	**Square Planar**	Planar structure θ = 90° (Four) Imp. Ex. : XeF_4, ICl_4^- etc. Both l·p must be opposite to each other.

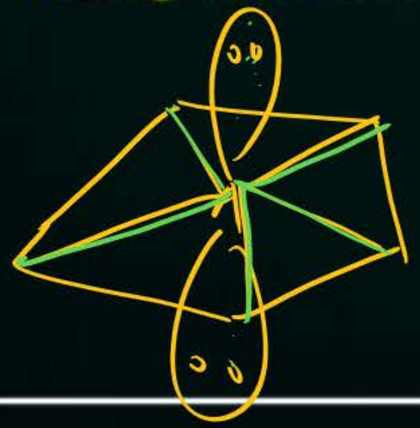
to avoid l·p-l·p repulsion at 90°.

XeF_4 AB_4L_2 Sq Planar





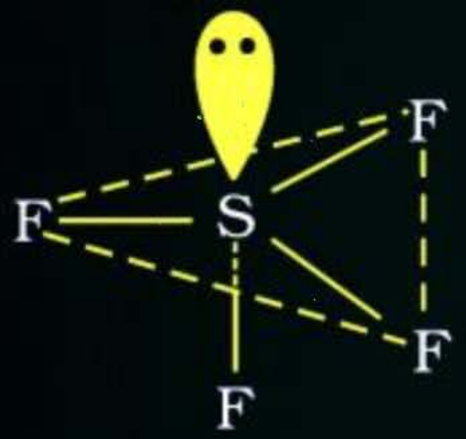
Not in NCERT

Molecule Type	Shape/Molecular Geometry	Remarks
AB_6L_1	**Distorted Octahedral**	Non-planar structure $\theta \neq 90°$ Imp. Ex. : XeF_6 also known as Capped octahedral.
AB_5L_2	**Pentagonal Planar** 	[redacted]-planar structure $\theta = 72°$ (Five) Imp. Ex. : $[XeF_5]^-$

Lone pair position in AB_4L_1 see-saw molecule

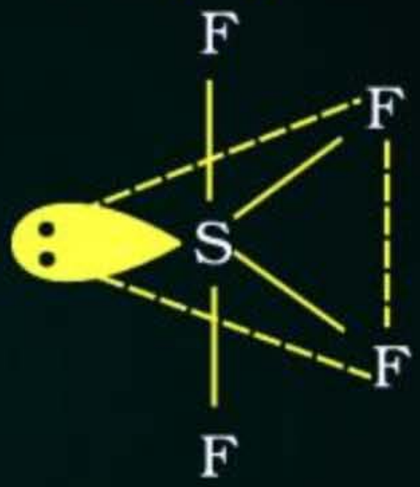
Ex. SF_4

(A)



3 l·p-b·p repulsions at 90°

(B)



See-Saw

2 l·p-b·p repulsions at 90°

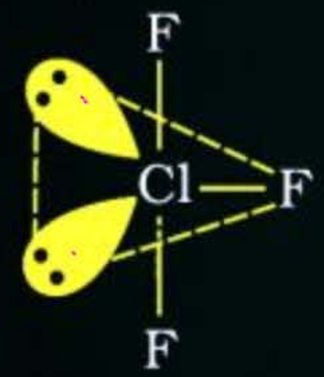
More stable

B is more stable

Lone pair position in AB_3L_2 Bent T molecule

Ex. ClF_3

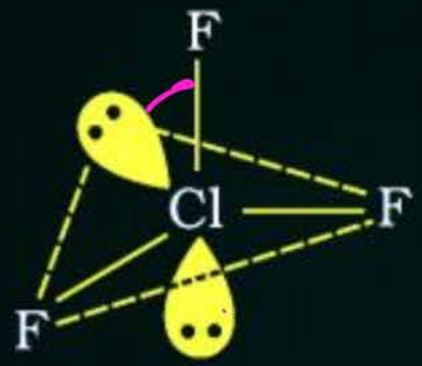
(A)



4 l.p - b.p repulsions (less in number)

More stable

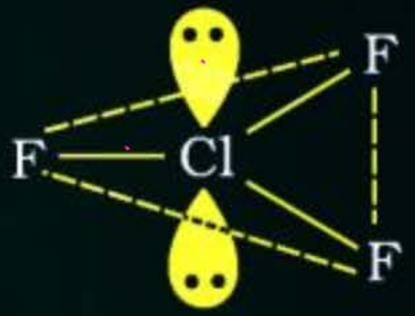
(B)



1 l.p - l.p repulsion at 90°

3 l.p - B.P repulsion at 90°

(C)



6 l.p - b.p repulsions at 90°

AB_5L_0

(l.p occupies equatorial positions in T.B.P parent geometry.

AB_4L_1

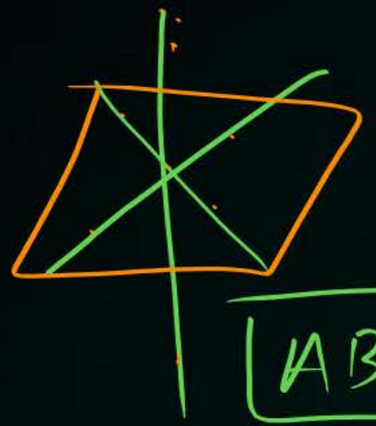
See Saw

AB_3L_2

Bent-T

AB_2L_3

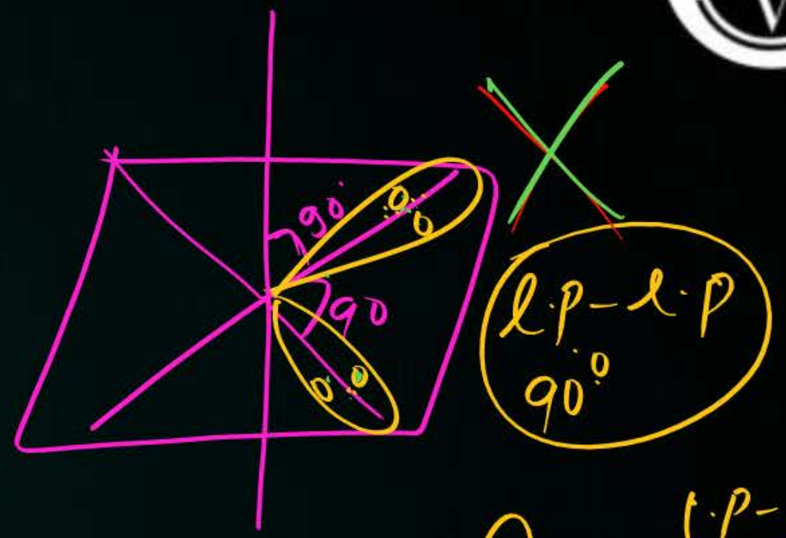
linear



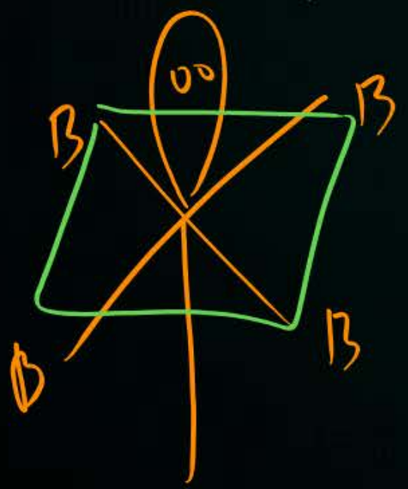
$a = e$

90°

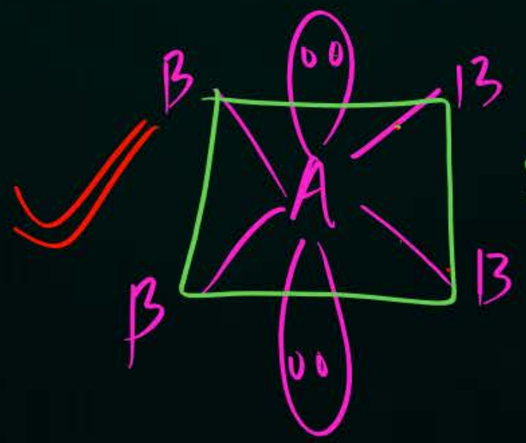
AB_6L_0



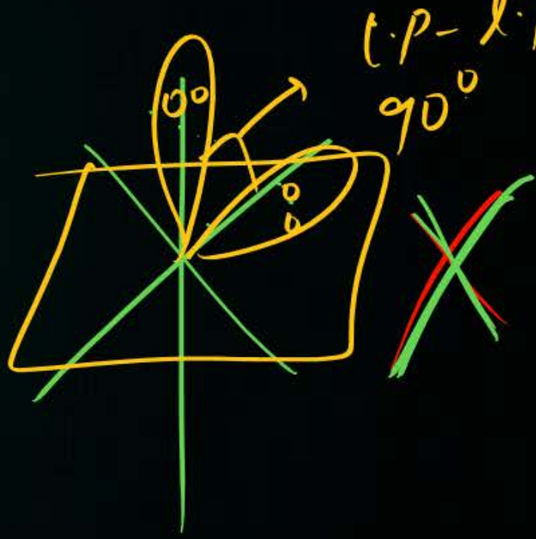
AB_5L_1 Sq. Pyramidal



AB_4L_2



Sq. planar.



QUESTION

Which of the following is planar species :

1. CH_4 AB_4L_0 ✗
2. SF_4 AB_4L_1 Non planar ✗
3. BCl_3 AB_3L_0 Planar ✓
4. All of these

QUESTION

Which of the following molecules has trigonal planar geometry :

1. NH_3
2. BF_3
3. PCl_3
4. IF_3

H.W

QUESTION

Among the following molecules

(i) XeO_3 AB_3L_1 (ii) $XeOF_4$ AB_5L_1 (iii) XeF_6 AB_6L_1

Those having same number of lone pairs on Xe are :

1. (i) and (ii) only
2. (i) and (iii) only
3. (ii) and (iii) only
4. (i), (ii) and (iii)

QUESTION

In the protonation of H_2O, charge occurs in :

1. Hybridisation state of oxygen

H.W

2. Shape of molecule

3. Covalency of oxygen

4. (2) & (3) Both

Homework

From Module - 1

Questions Based on
Shape & Hybridisations

THANK YOU

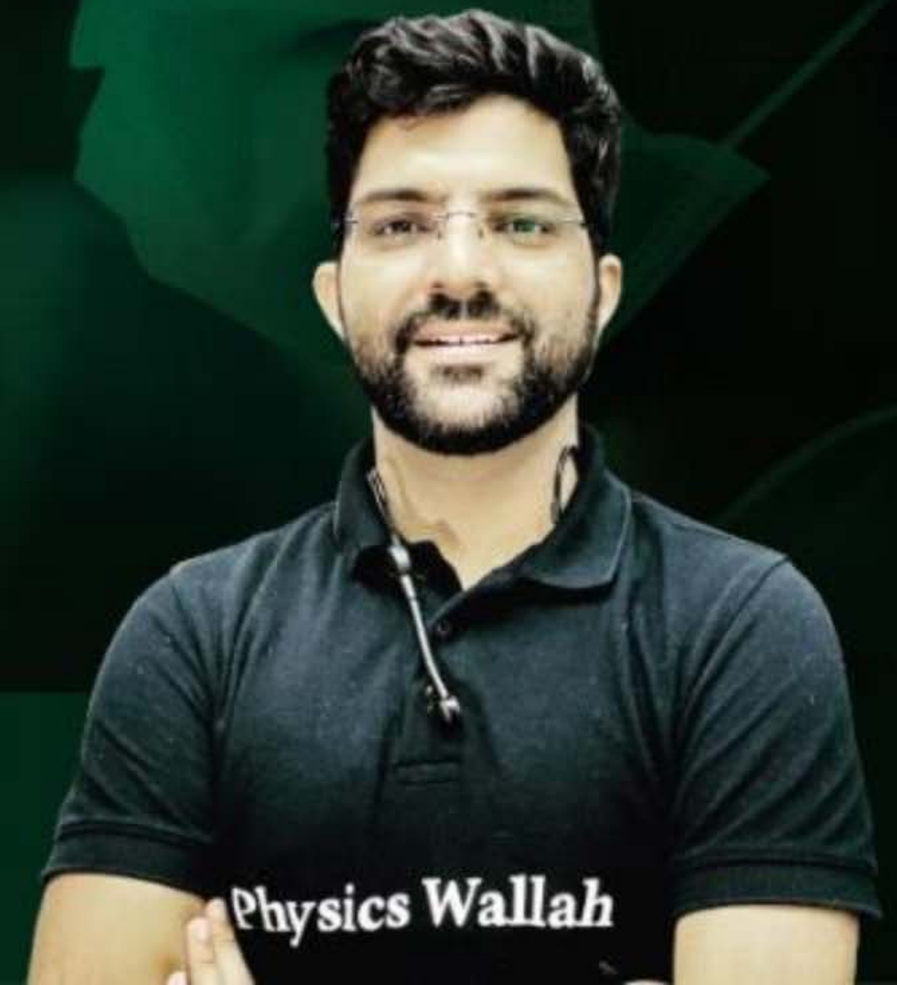
YAKEEN 2.0

FOR NEET 2025

Lecture - 06 | Inorganic Chemistry

Chemical Bonding & Molecular Structure

By - Mohit Dadheech (MD Sir)



Topics *to be covered*

1. Valence Bond Theory Part - I : Hybridisation

$H_2\underline{O} + H^+ \longrightarrow H_3\underline{O}^+$

AB_2L_2

sp^3

Bent

Covalency = 2

104.5°

AB_3L_1

sp^3

T. pyramidal

Covalency = 3

0 Use

l.p lagao
B.A Ghatao

$BF_3 + F^- \longrightarrow BF_4^-$

True / False

(1) Hybridisation change (T)

(2) Bond angle ↑se (F)

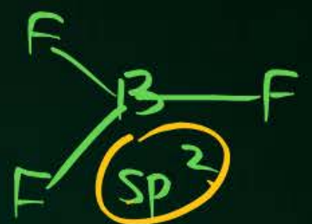
(3) Covalency ↓se (F)

(4) % s character in Hybrid orbital ↓se (T)

(5) planarity change (T)

(6) shape remain same (F)

BF_3

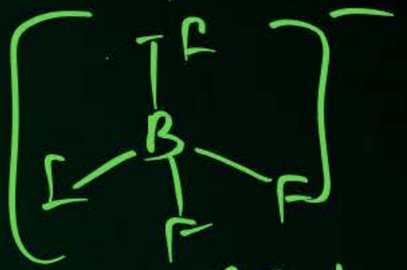


AB_3L_0

T. planar

Cov → 3 $\theta = 120^\circ$

BF_4^-



AB_4L_0

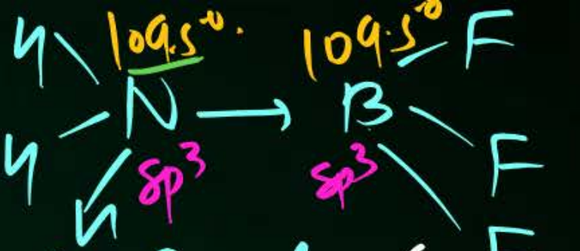
sp^3

tetra (Non plana

Cov = 4

$\theta = 109.5^\circ$

	sp^2	sp^3
%	33.33	25%



① Lewis Base - Lewis Acid Reaction (Neutralisation)

② Covalency arround B & N ↑se

③ Hybridisation of B Changed. But For N Remains Same.

④ Shape arround Both N & B has been changed (Tetrahedral)

⑤ Bond Angle arround B ↓se
θ arround N ↑se

Formation of CH_4 Without Hybridisation :-

C $2s^2 2p^2$

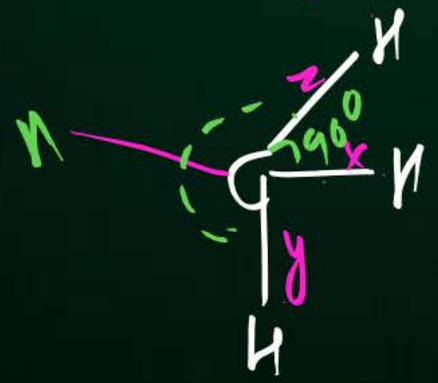
$C_{E.S.I}$: 2s | $2p_x$ $2p_y$ $2p_z$ — each box ↑

1s | 1s | 1s | 1s

H H H H

1 Bond → 2s – 1s (weak)

3 Bond → 2p – 1s (strong)



→ Covalency = 4 (Tetra valent) (T)

→ Non Planar (T)

→ Position of 4th C–H Bond is (T)
Uncertain w.r.t 3 C–H Bonds.

→ All C–H Bonds are equivalent (F)

→ 3 C–H Bonds are stronger than 1 C–H Bond (T)

→ Tetrahedral (F)
θ 109.5°

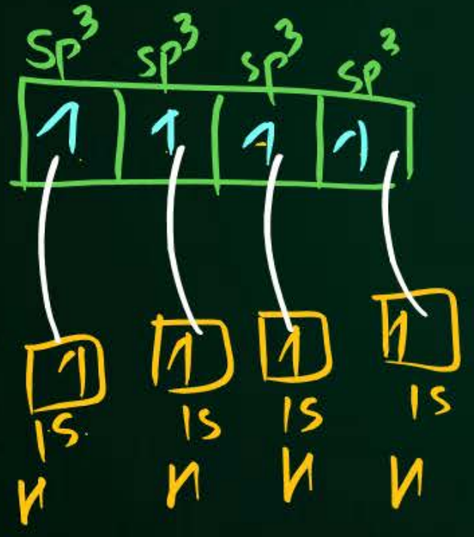
CH_4 with Hybridisation (Real)

C $2s^2\ 2p^2$

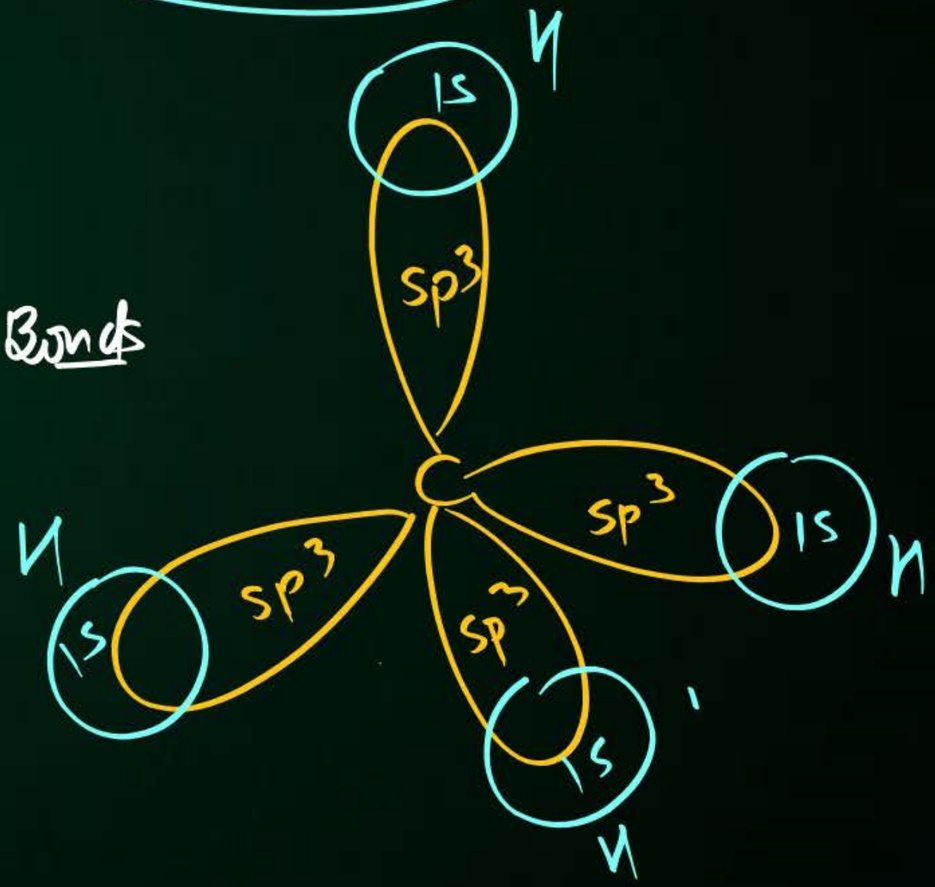
C (E.S.I) — 2s | $2p_x$ | $2p_y$ | $2p_z$

$(s+p+p+p) \Rightarrow (sp^3, sp^3, sp^3, sp^3)$

(Tetravalent)
Covalency = 4
Nonplanar ✓
Tetrahedral ✓
$\theta = 109.5^\circ$ ✓
All Bonds are equivalent ✓



Four $(sp^3 - 1s)$ Bonds



Q In CH_4 Molecule Hybridisation is Needed to Explain

(1) Tetravalency of C

(2) Non planarity.

(3) tetrahedral geometry around C

(4) All of these.

Valence Bond Theory Part - I : Hybridisation

In hybridisation orbitals having same or similar energy combine with each other & form new orbitals of same energy.

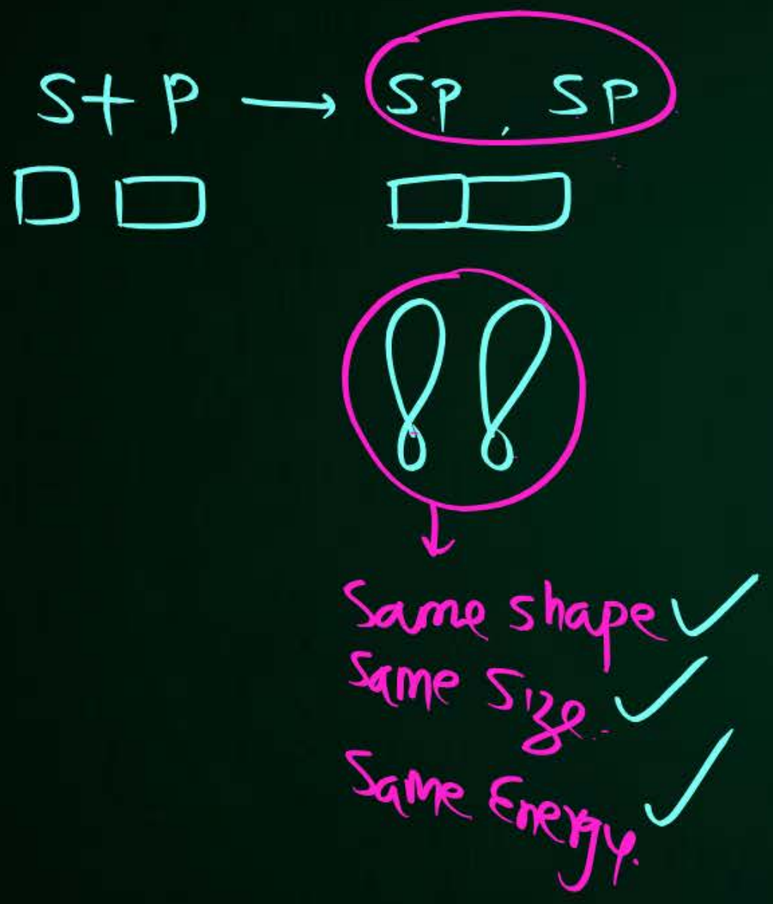
Important Points :

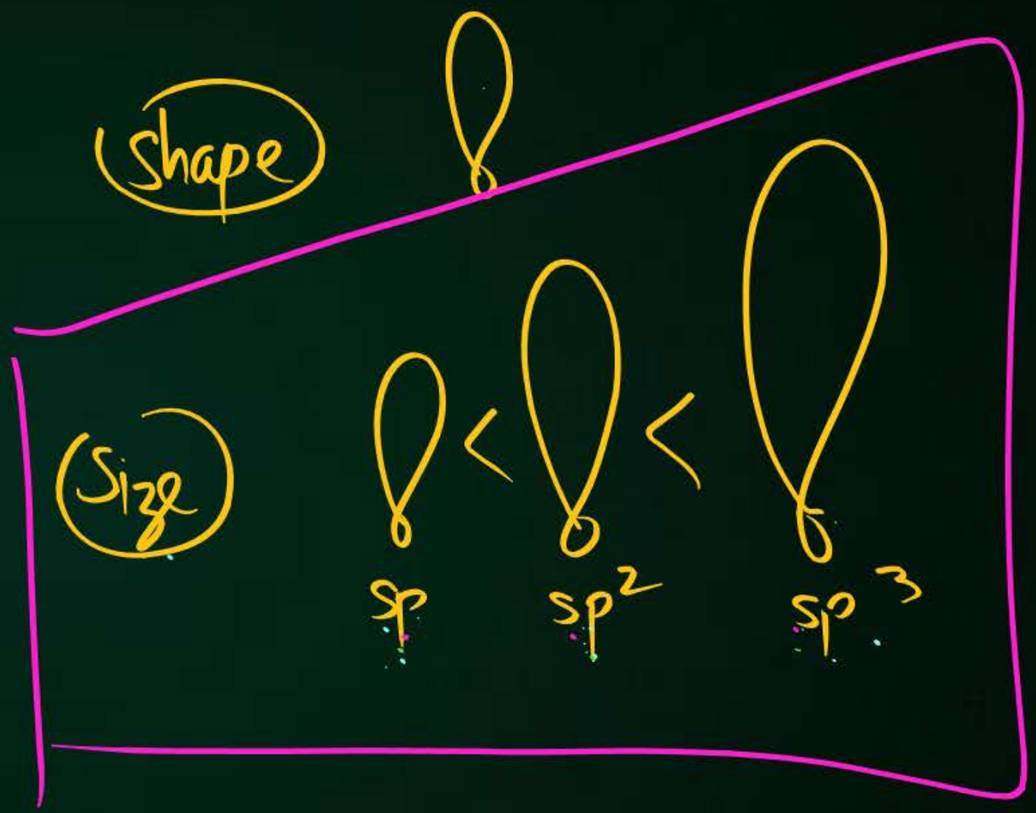
1. The number of hybrid orbitals is equal to the number of the atomic orbitals that get hybridised.

Jitne milenge → Utne Banenge.
(A.O) (H.O)

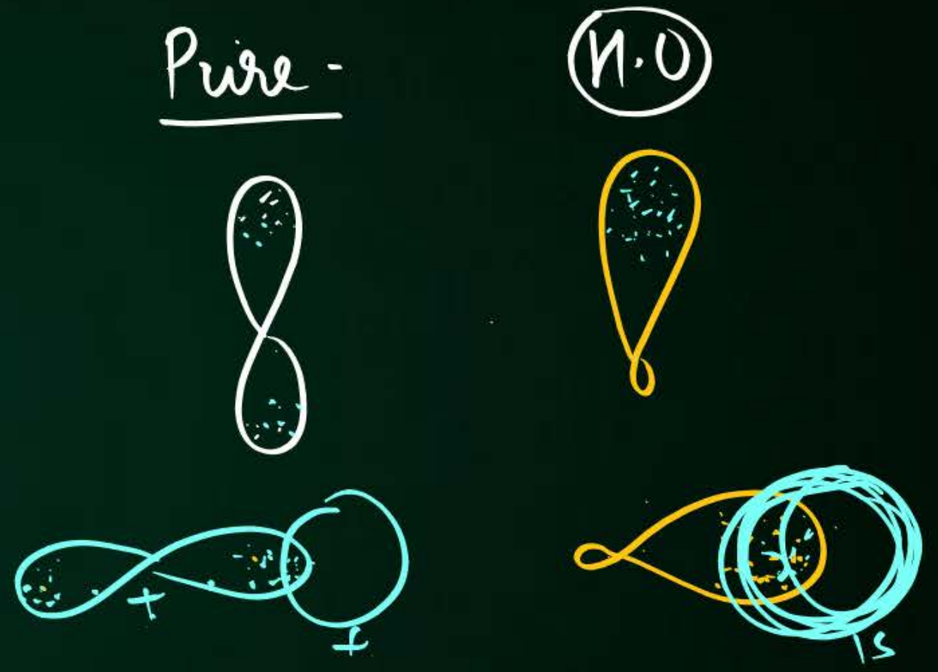
- Hybridisation is reconstruction & reorganization of orbitals. ✓

2. The hybridised orbitals are always equivalent in energy and shape.

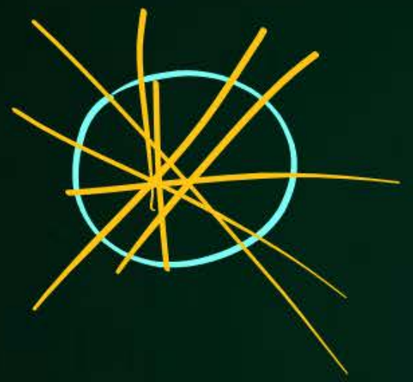




3. The hybrid orbitals are more effective in forming stable bonds than the pure atomic orbitals.



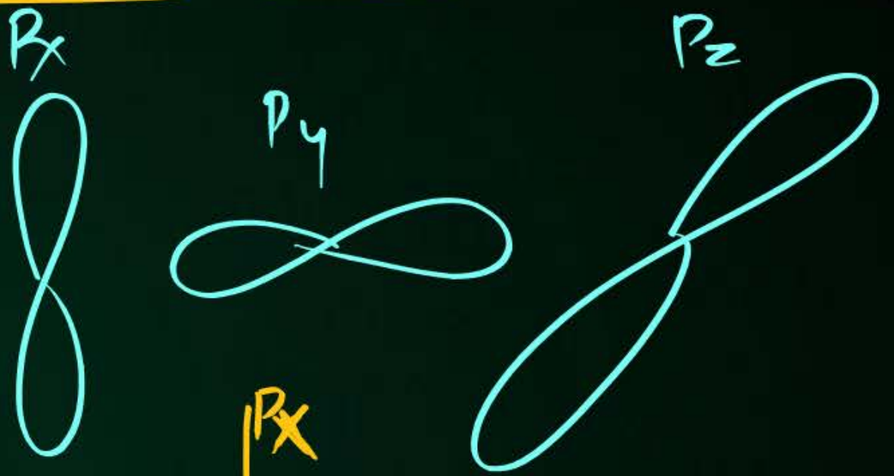
4. During the mixing of s & p orbitals directional nature of s increases while p increases its angular nature.

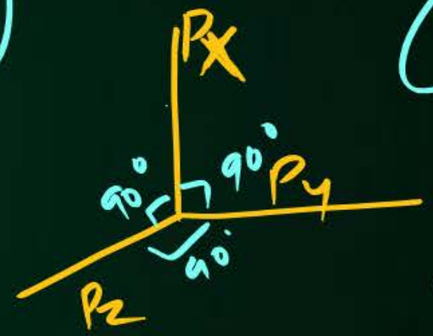


$\theta \Rightarrow$ koi kami nahi

"s" Angle ki dukaan nai

directional ✗





directional ✓

Angle → only 90°

1s + 2p 2s + 2p ✓
3s + 3p + 3d ✓✓

Important conditions for hybridization :

1. The orbitals present in the valence shell of the atom are hybridised. (It is orbitals which hybridize not e^-) ✓
   3d + 4s ✓✓ d-Block
2. Orbitals having paired e^-, single e^- & vacant orbitals all can participate in hybridisation.
3. Excitation or promotion of e^- is not an essential condition prior to hybridization. ✓
4. Only those orbitals need to hybridize which forms σ bond & keep the lone pair.
5. So the no. of hybrid orbital = σ bond + lone pair (n) + (m).

AB_nL_m

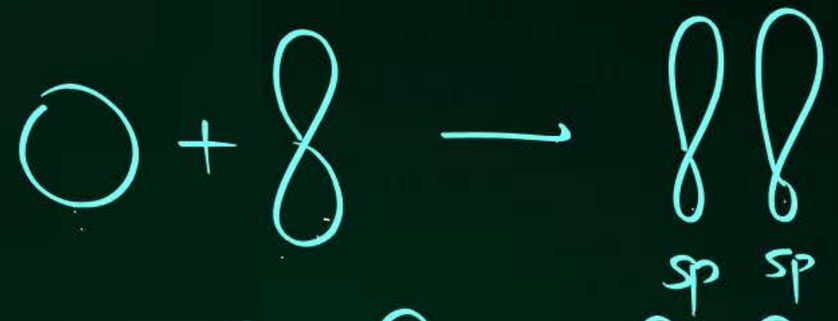
3d { 4s
Low Energy gap.

MDJ → H.O Ke sirf 2 Kaam
① → σ Banayega
② → l.p Rakhega.

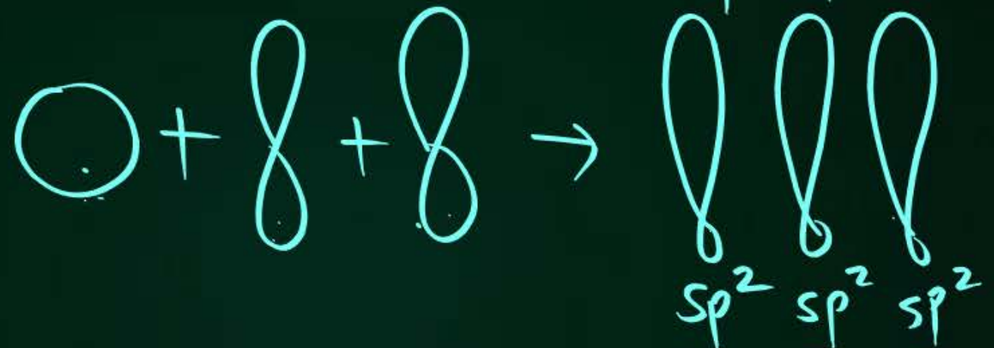
Type of Hybridisation

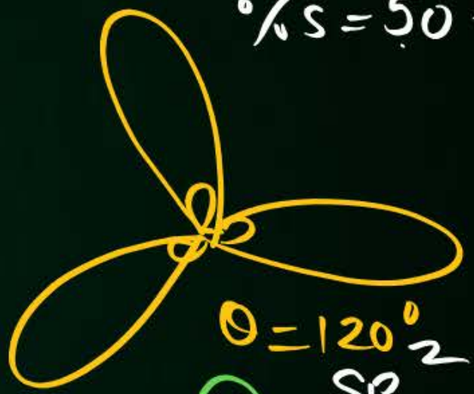
orientation

(i) sp

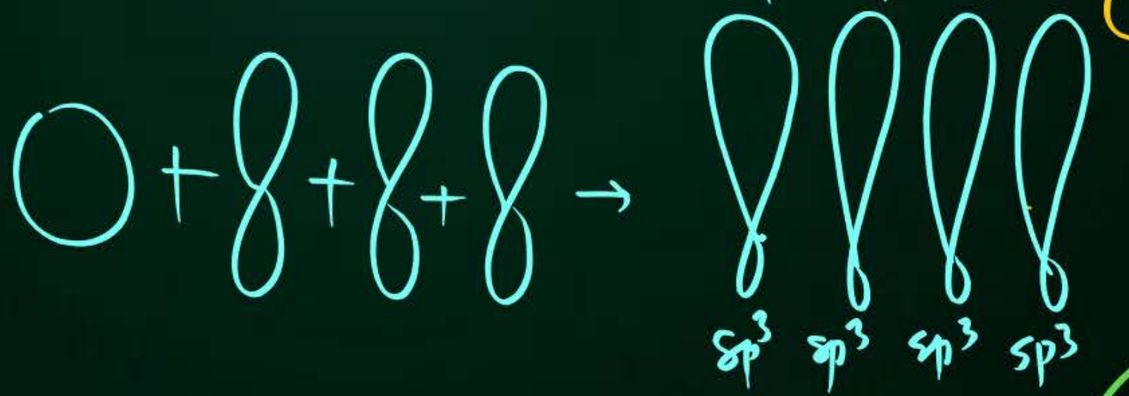


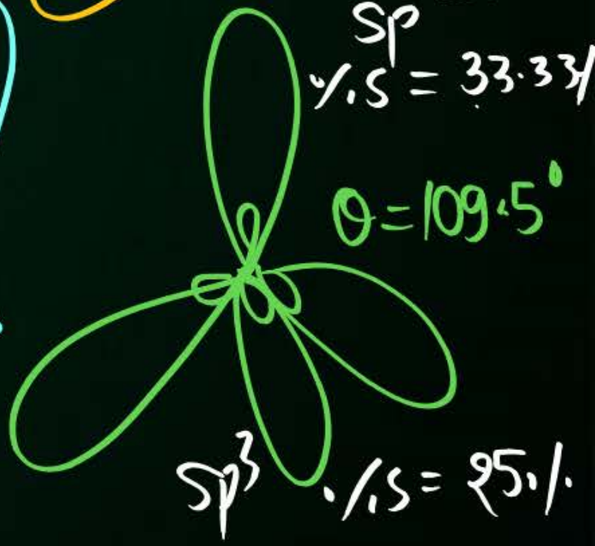
(ii) sp^2





(iii) sp^3





Type of d-orbitals used in hybridization :

sp^3d = d_{z^2}

sp^3d^2 = d_{z^2}, $d_{x^2-y^2}$

sp^3d^3 = d_{z^2}, $d_{x^2-y^2}$, d_{xy}

(d) Vala Hybridisation

↓

group Hybridisation

sp^3d = sp^2 + Pd
(s+p+p)

sp^3d^2 = sp^2d + Pd

sp^3d^3 = sp^2d^2 + Pd

Q Set of orbitals used in Hybridisation of 'S' during the Formation of SF_6 Molecule.

SF_6 AB_6L_0 | sp^3d^2

$S + P_x + P_y + P_z + d_{z^2} + d_{x^2-y^2}$

Q In which of the following species both axial & non axial d orbitals are used in hybridisation

(1) SF_4 AB_4L_1 sp^3d — $(d_{z^2}, d_{x^2-y^2})$ axial.

(2) ICl_4^- AB_4L_2 sp^3d^2.

(3) ✓ XeF_6 AB_6L_1 sp^3d^3 → $d_{z^2}, d_{x^2-y^2}, d_{xy}$ — d_{xy}, d_{yz}, d_{xz} Non axial.

(4) SF_2 ✗ AB_2L_2 sp^3

(H.W)

d-orbitals used.

d orbitals remains Pure

XeF_4

IF_7

ICl_2^-

XeF_2

ClF_3

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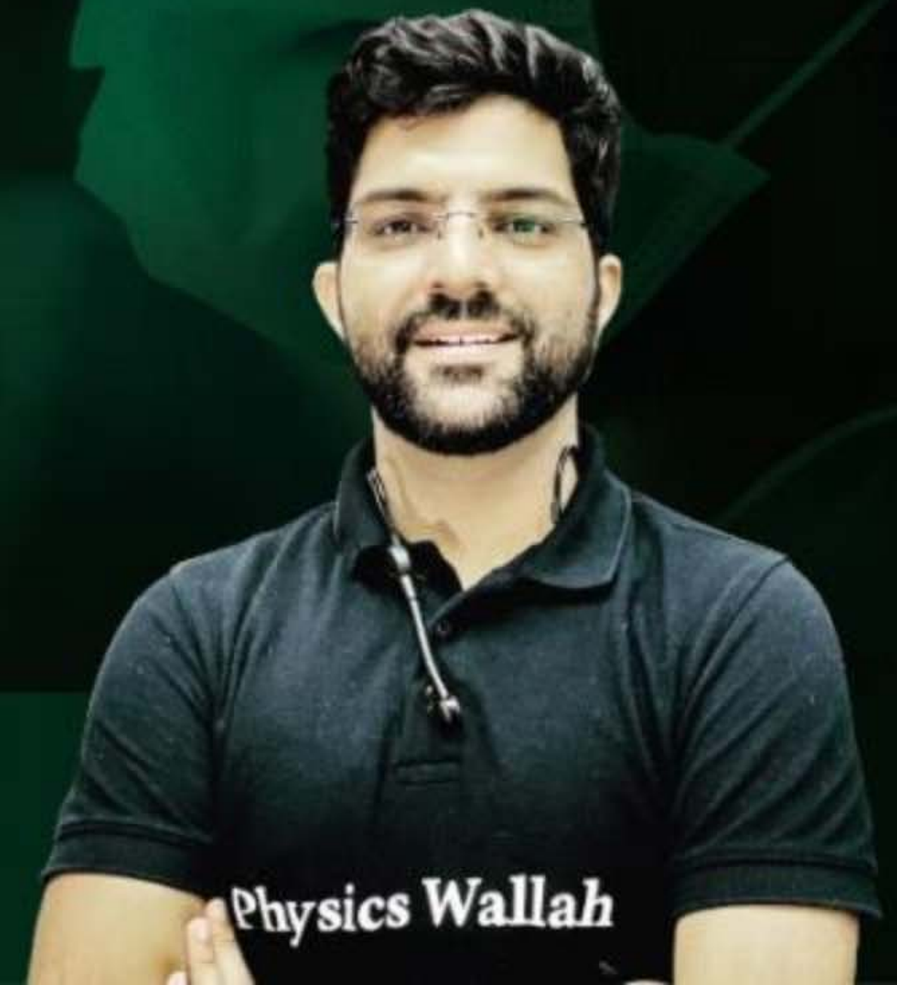
FOR NEET 2025

Lecture - 07 | Inorganic Chemistry

Chemical Bonding & Molecular Structure

By - Mohit Dadheech (MD Sir)



Topics *to be covered*

1. Valence Bond Theory Part - 2 : Overlapping
2. Bond Identity

Overlapping :

According to orbital overlap concept, the formation of a covalent bond between two atoms results by pairing of electrons present in the valence shell having opposite spins.

(Orbital)

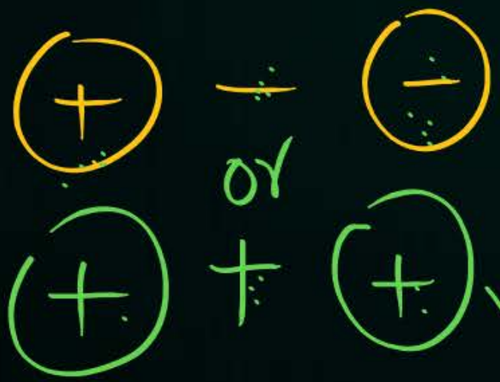
Mechanism of Covalent Bond formation.

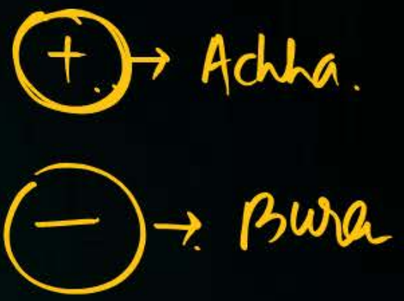
MDJ

⇒ Positive overlapping.

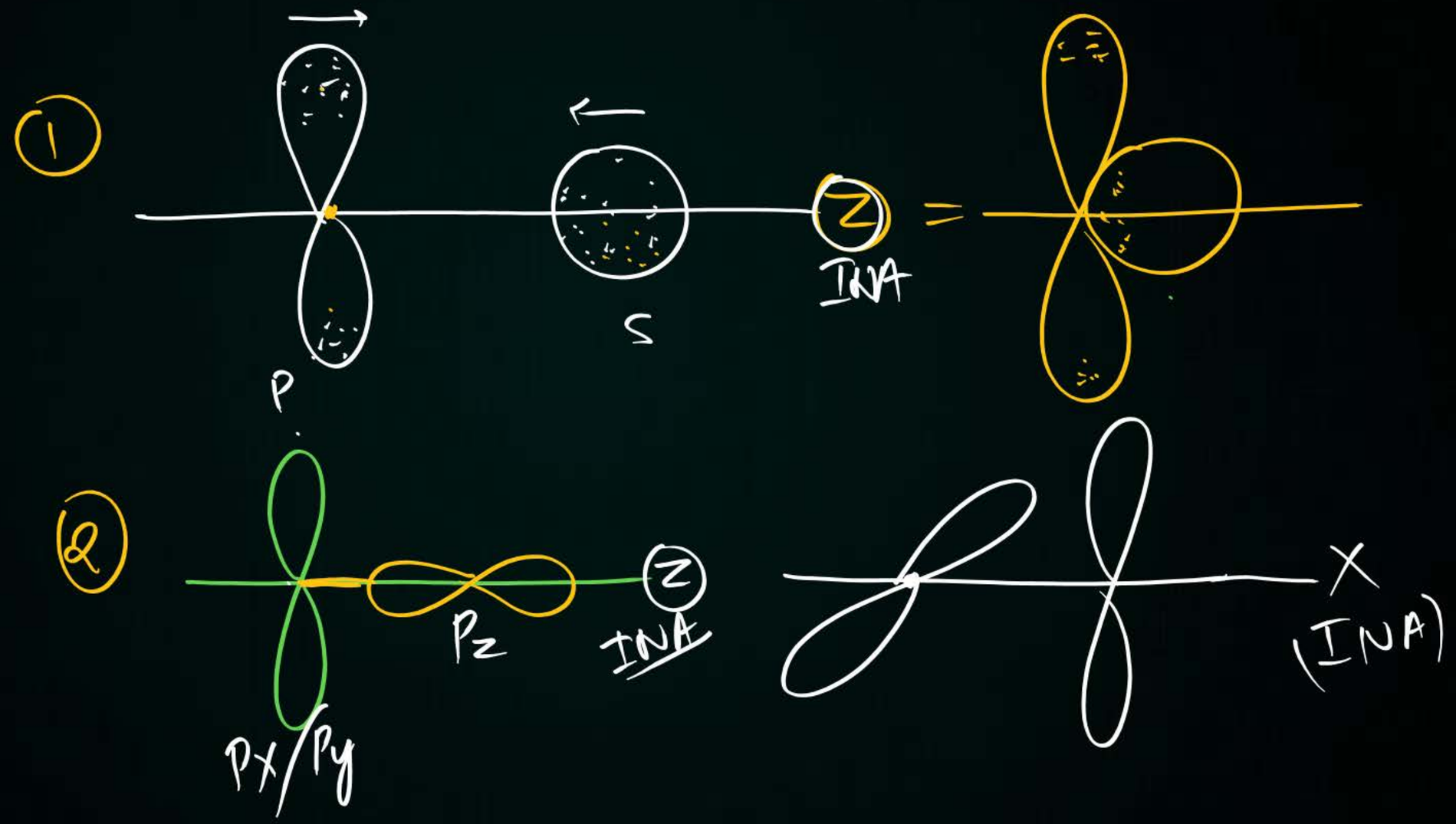
⇒ Negative overlapping.

Positive overlapping.

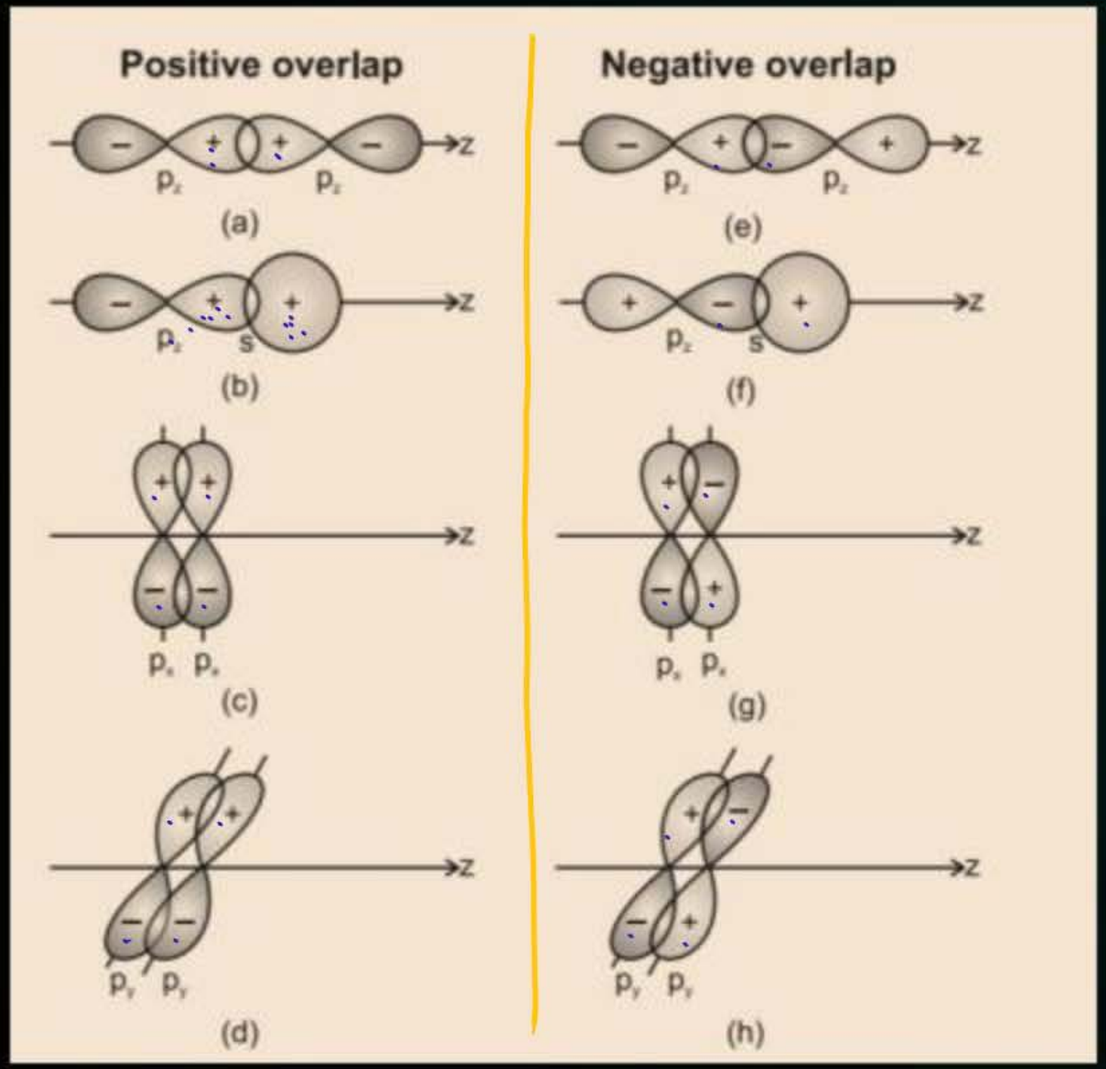

or
Positive overlapping.

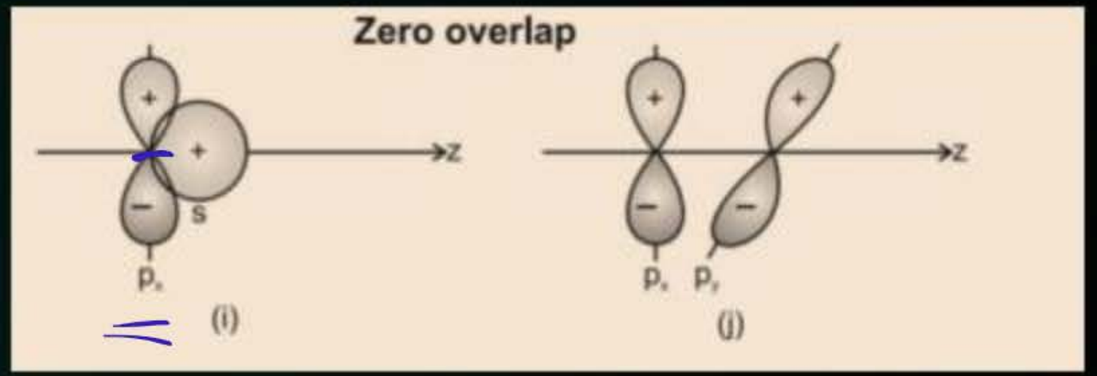

→ Achha.
→ Bura

Zero overlapping



Overlapping of Pure Atomic Orbitals





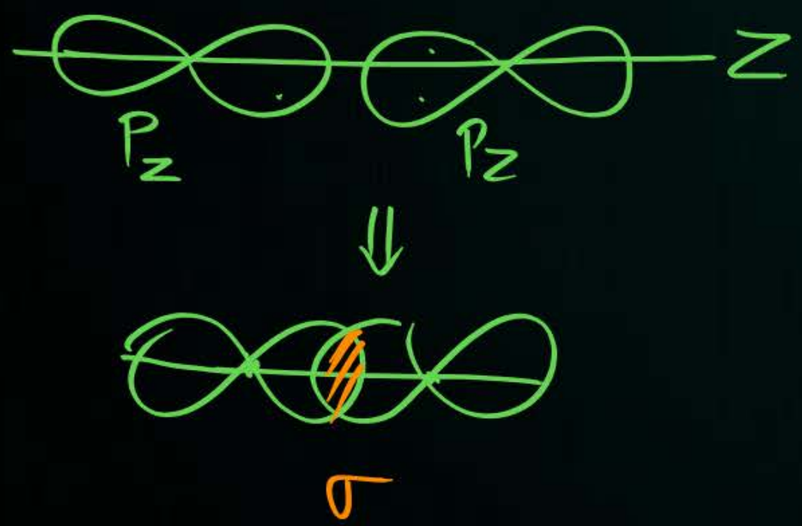
Types of Overlapping

NOTE σ Bond is stronger than π
∴ Overlapping Extent is more in Head on overlapping

Co-axial / Head-on overlapping

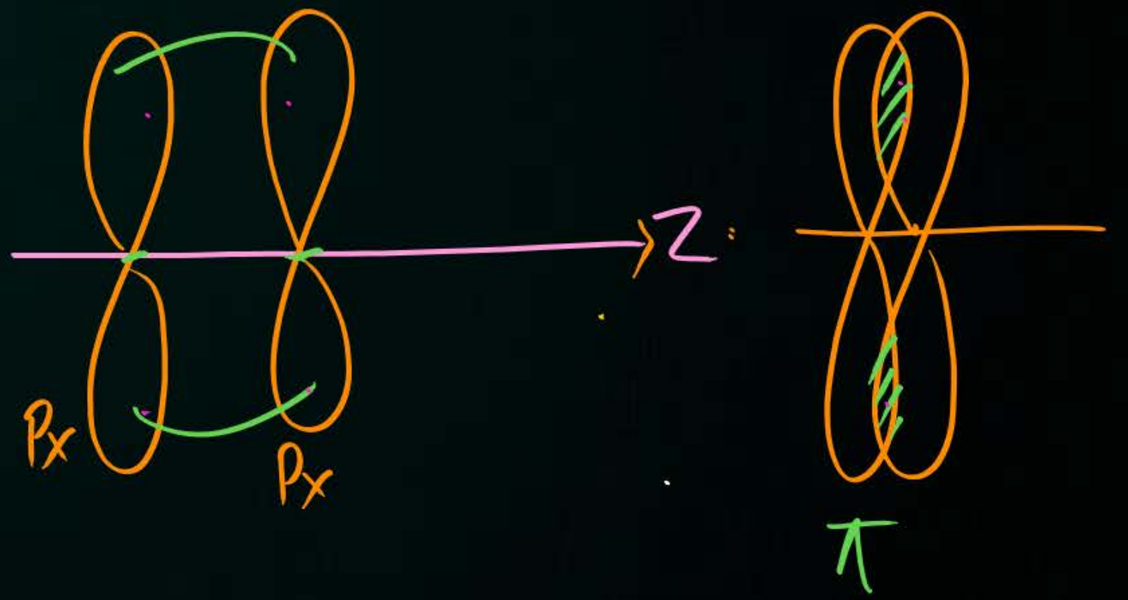
σ Bond Formation

Mixing Along the Internuclear axis (INA)



Collateral / Sideways overlapping

π Bond Formation.
Perpendicular to INA



$C-C < C=C < C\equiv C$ (Bond strength. or Bond Energy)

200

σ

$\sigma + \pi$

$200 + 100$

300

$\sigma + \pi + \pi$

$200 + 100 + 100$

400

Overlapping

Pure + Pure

$s + s \Rightarrow \sigma$

$s + p \Rightarrow \sigma / 0$

$p + p \Rightarrow \sigma / \pi / 0$

$p + d \Rightarrow \pi / 0$

$d + d \ \pi / 0$

Hybrid + Pure

Ex

$sp - s/p$

$sp^2 - s/p$

$sp^3 - s/p$

Bond = σ

Hybrid + Hybrid

Ex $sp^3 - sp^3$

$sp^2 - sp^2$

$sp - sp$

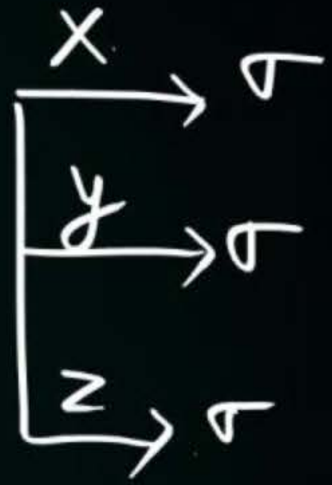
Bond $\Rightarrow \sigma$

Overlapping

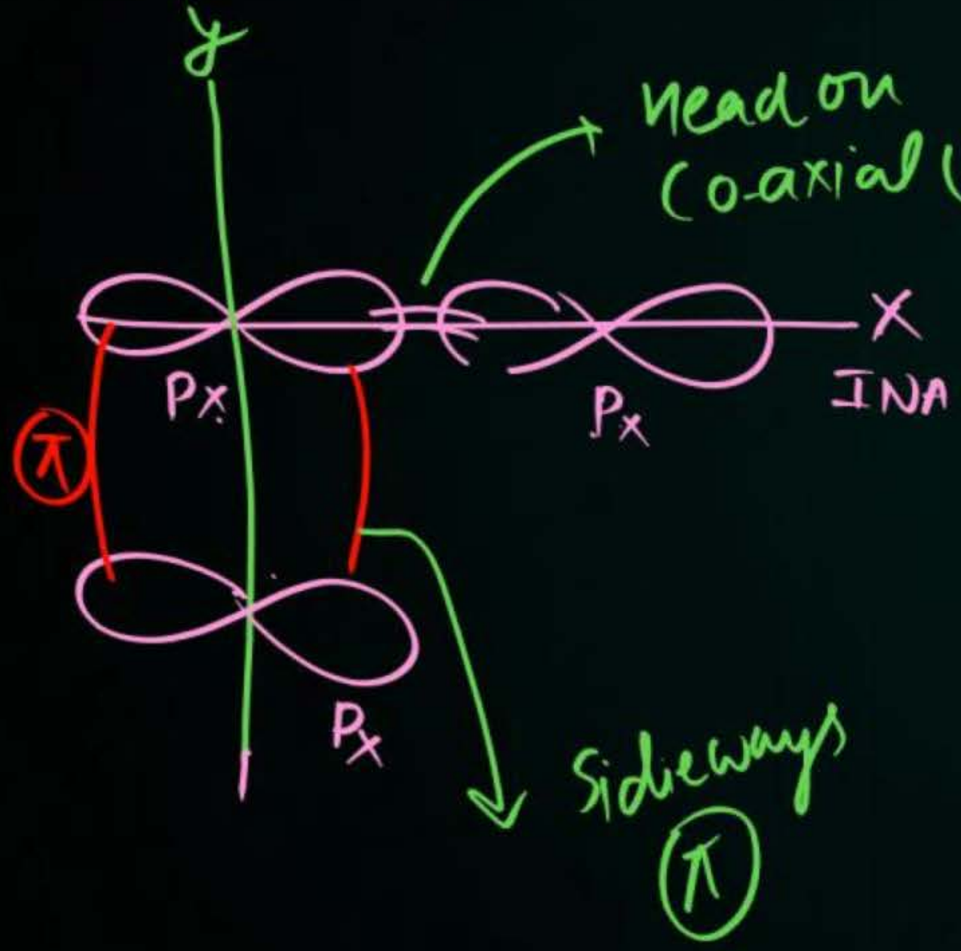
① s – s

INA

s, s



(2) p – p overlapping



$P_x + P_y$

X 0
Y 0
Z 0

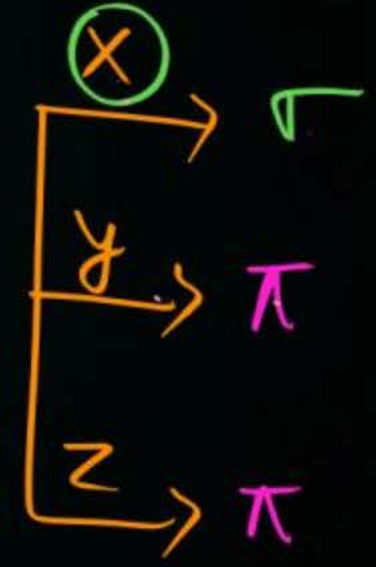
Both axis must be Same

MDJ **

Common par σ

Baki par π

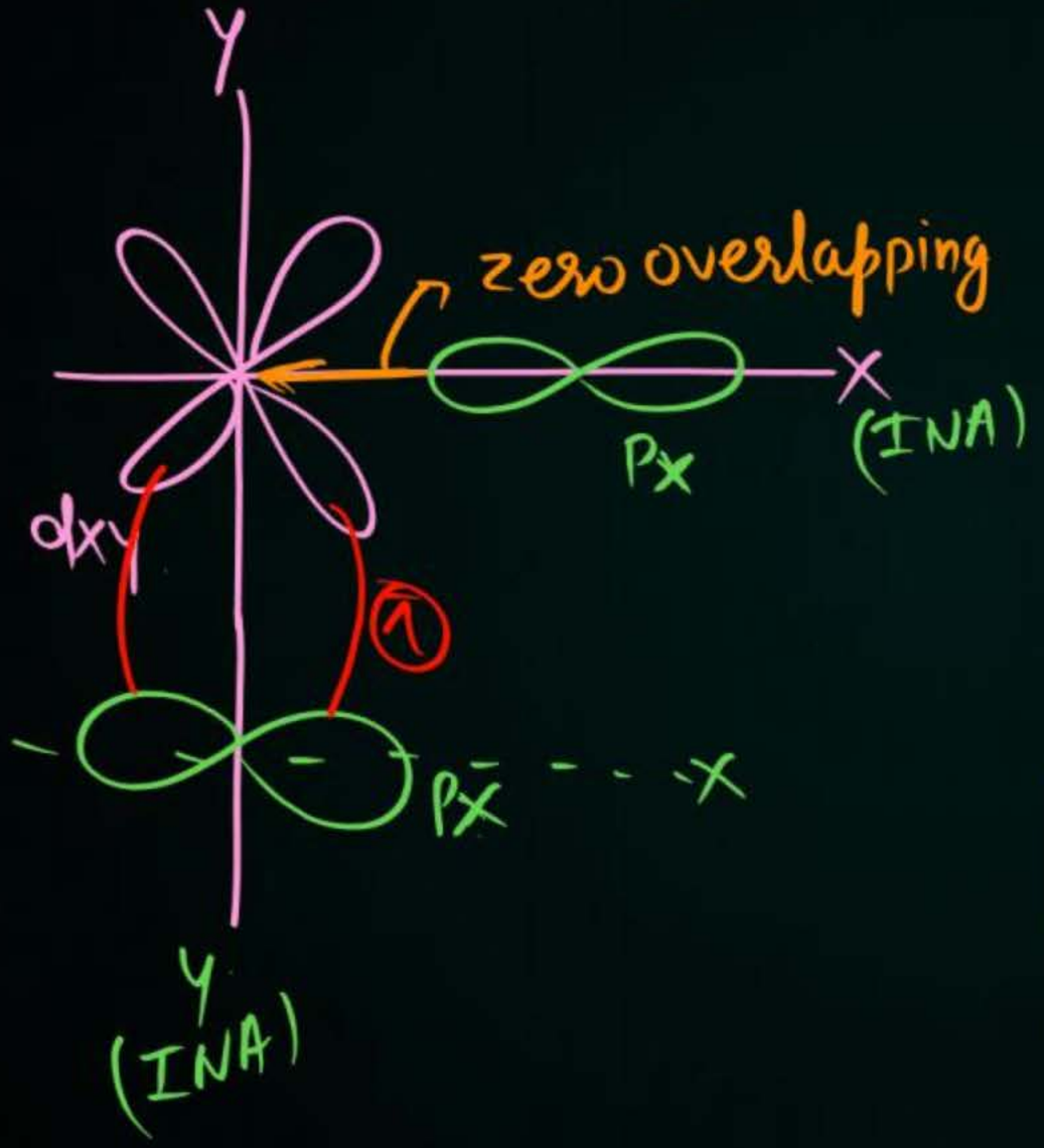
$P_{\otimes}, P_{\otimes}$



$P_{(y)}, P_{(y)}$

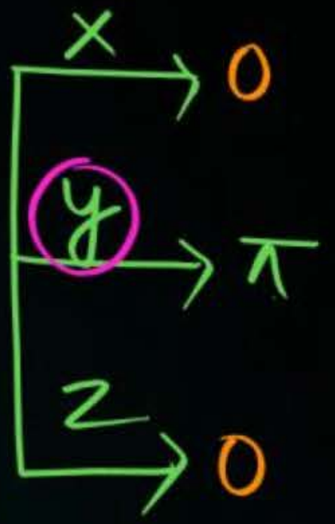
X π
(y) σ
Z π

(3) p-d overlapping



dx(y), Px

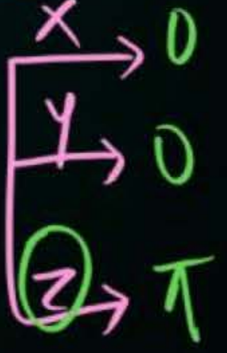
MDJ



In dono mai jo Uncommon axis hai Us par π

Baki zero

dyz(x), Py



d_{xy} , p_z

x → 0

y → 0

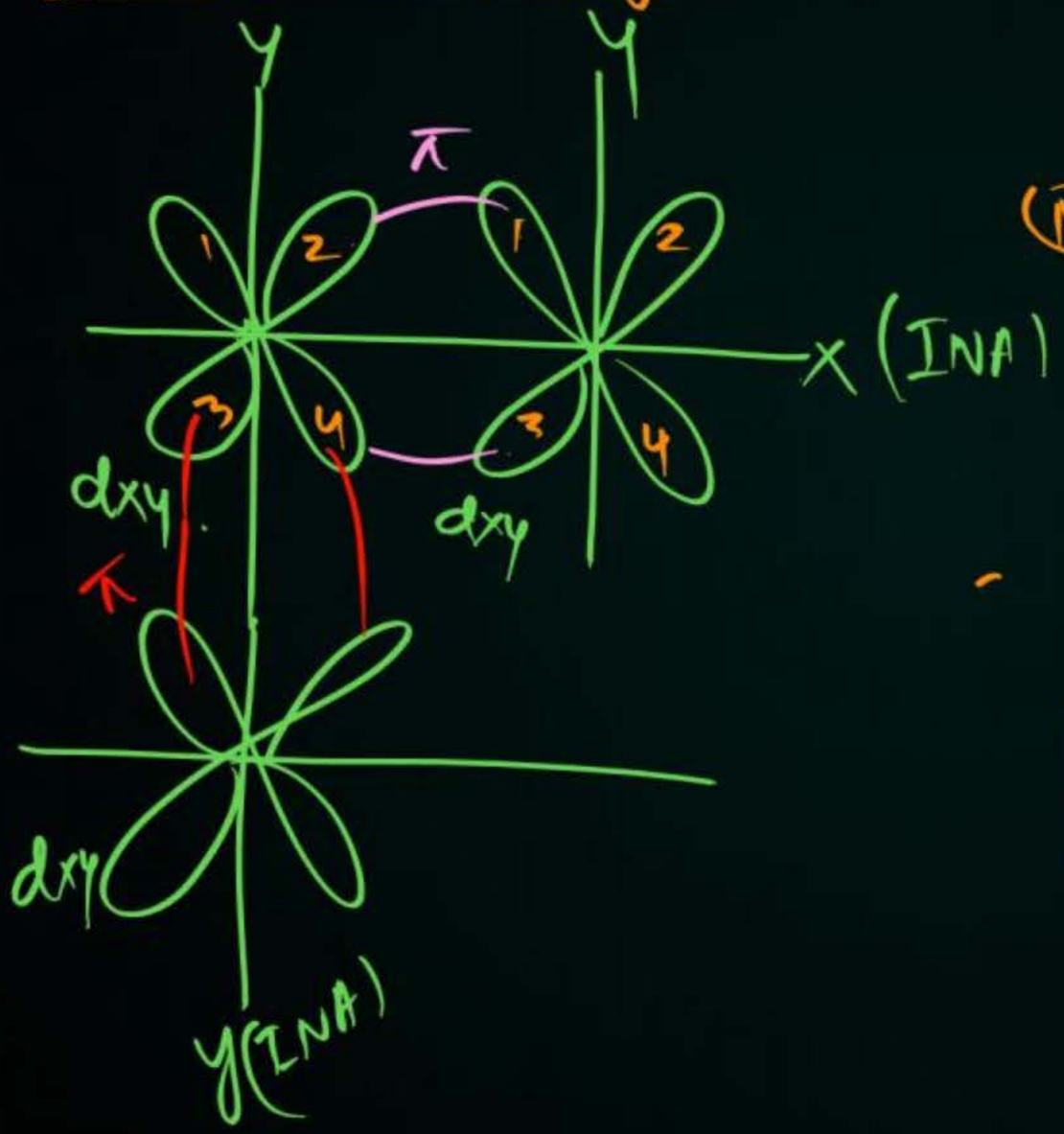
z → 0

Q

$d_{xz} + p_z \xrightarrow{INA = ?} \pi$

INA = X

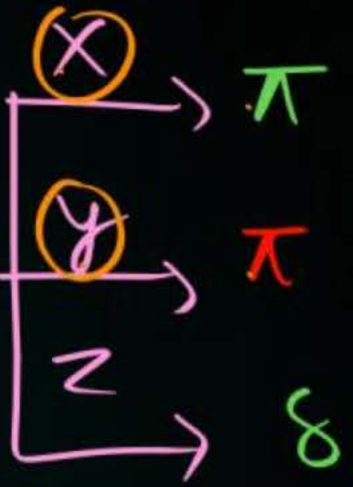
④ d-d overlapping



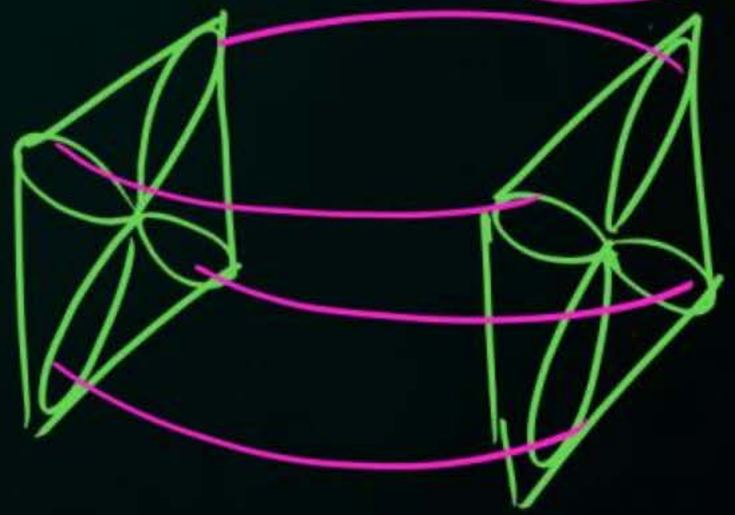
dxy . dxy

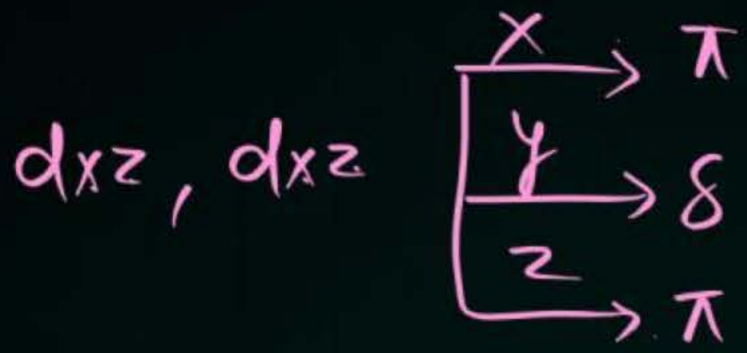
(MDJ)

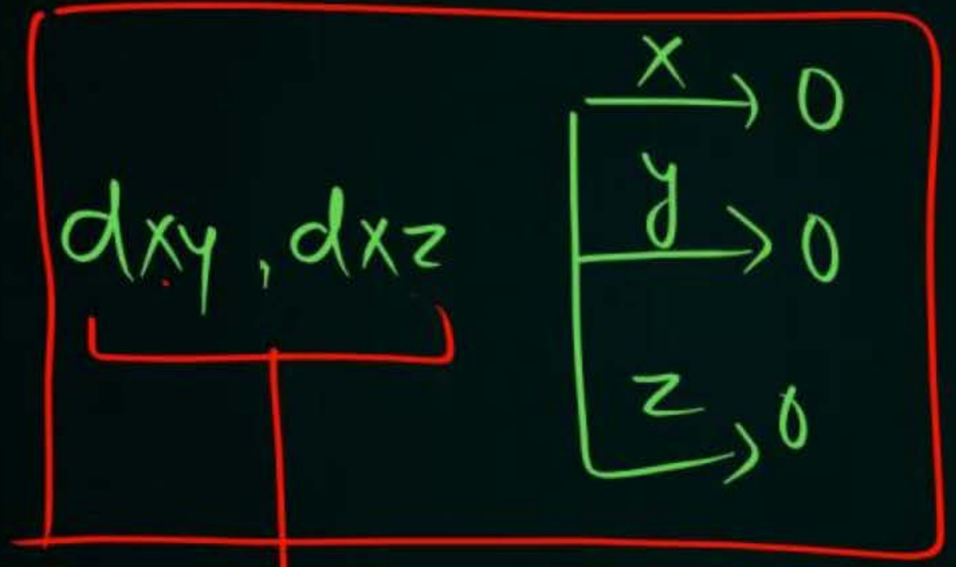
Common par
π baki par δ



δ Bond

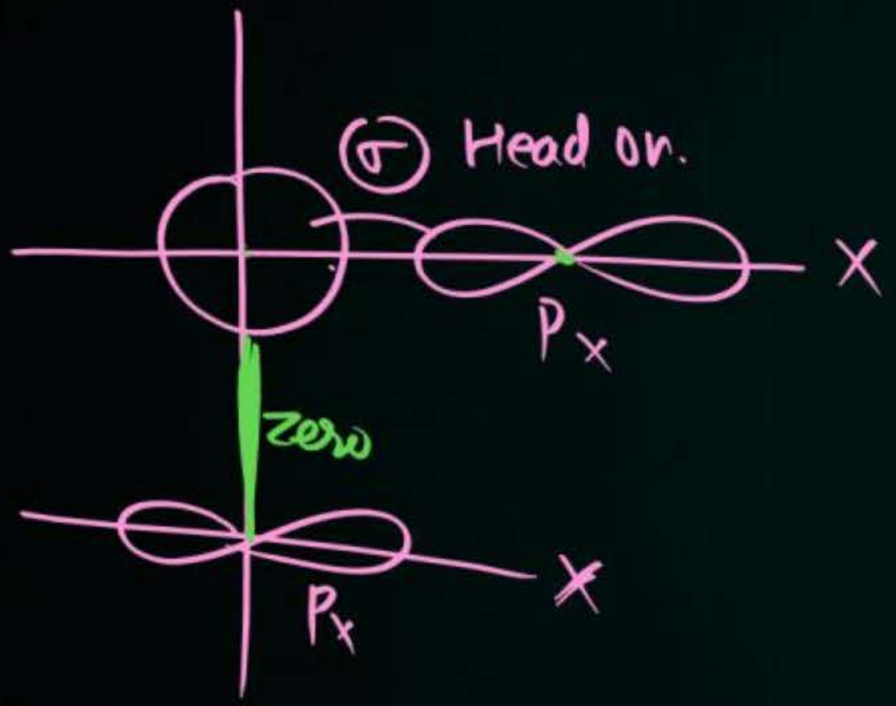






* Both d must be same

(5) S – P overlapping :-



S, P (X)

(X)	σ
Y	0
Z	0

(MDJ) Common par σ

Baki zero

S, P (Y)

X	0
(Y)	σ
Z	0

Home work

	(INA)	Type of Bond / zero
$P_x + P_x$	Y	
$P_y + P_x$	Z	
$P_z + P_z$	X	
$S + P_z$	Z	
$S + S$	Y	
$P_y + d_{xy}$	X	
$d_{xz} + d_{xz}$	X/Z	

Bond Identity :

Ex ① H_2

$H \underset{(\sigma)}{-} H$

1s — 1s or s–s

② $H-F$

1s – 2p or s– p

(σ)

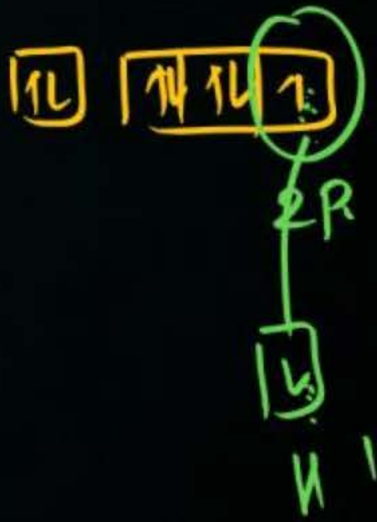
③ $F-F$

2p – 2p (σ)

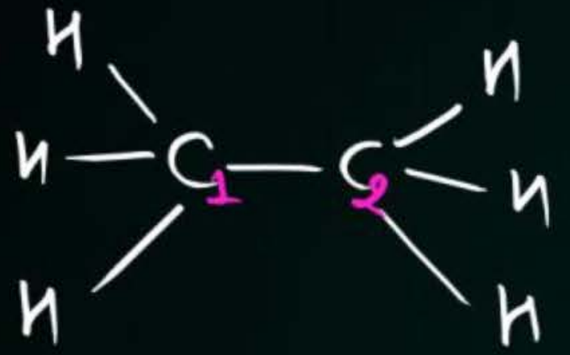
④ $Cl-Cl$

3p – 3p (σ)

F $2s^2 2p^5$



(5) $CH_3 - CH_3$

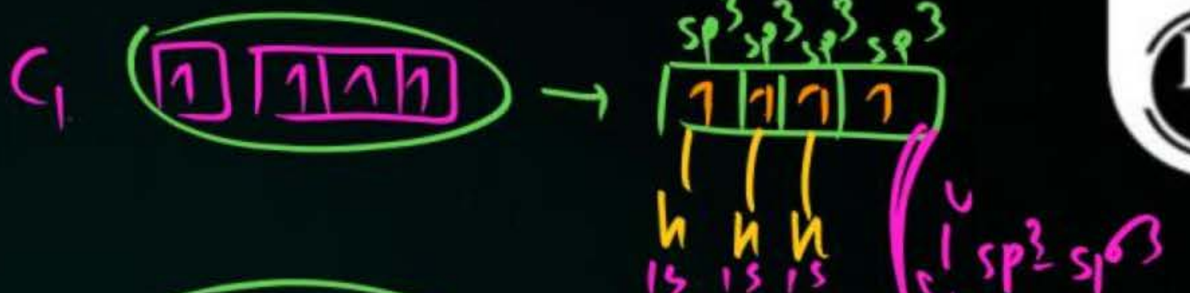


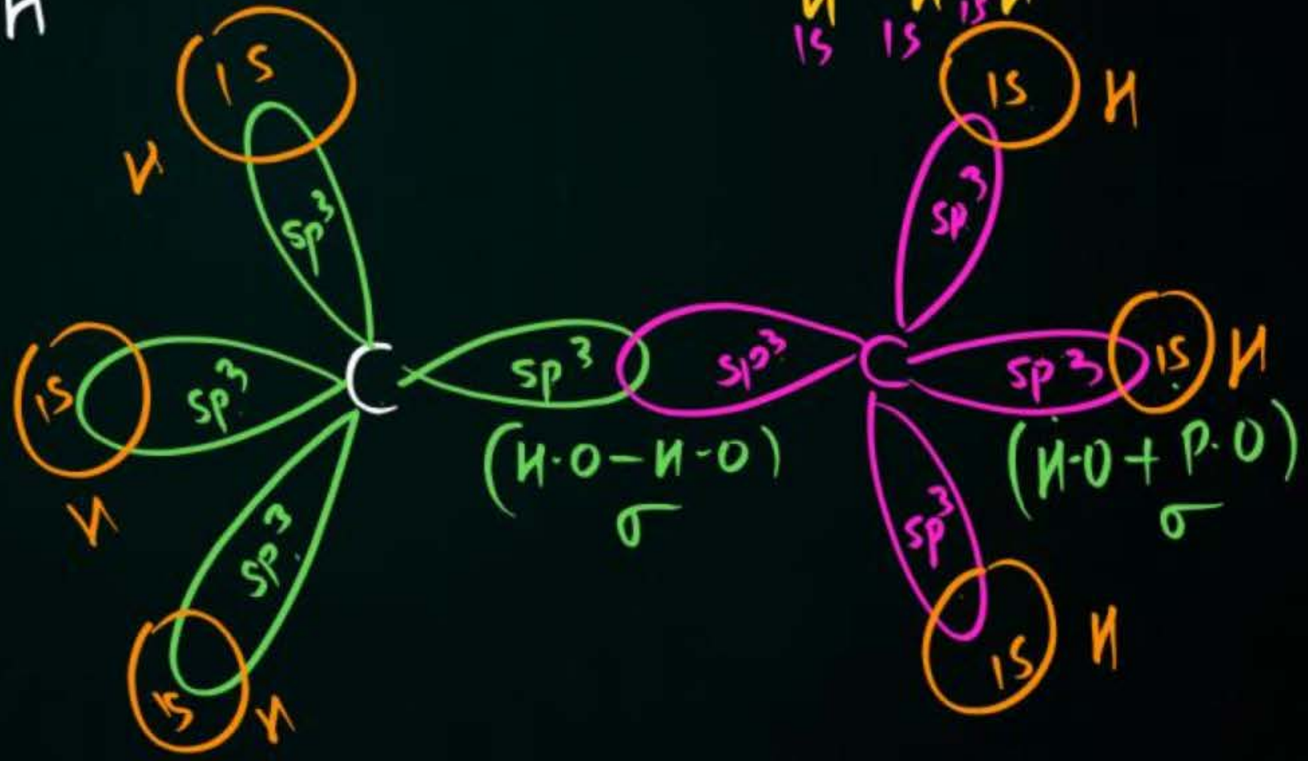
(one)

(σ) C – C (sp^3 – sp^3)

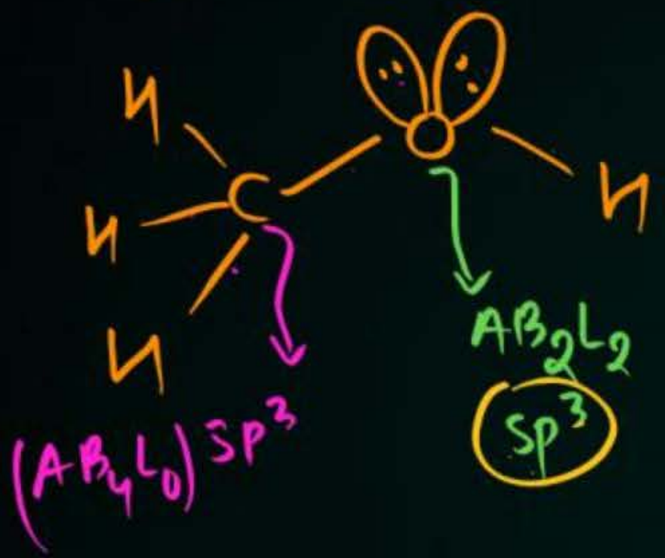
(σ) C – H (sp^3 – 1s)

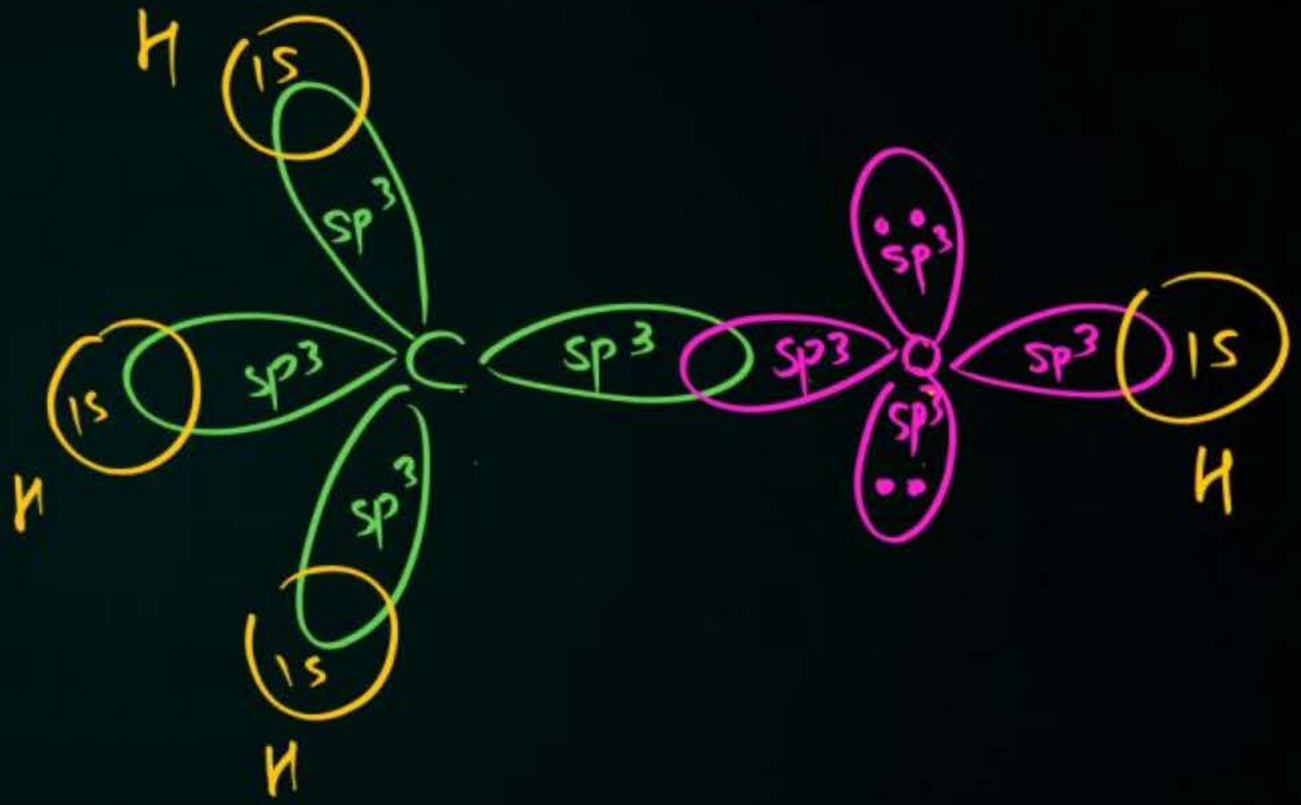
(six)





(6) CH_3OH



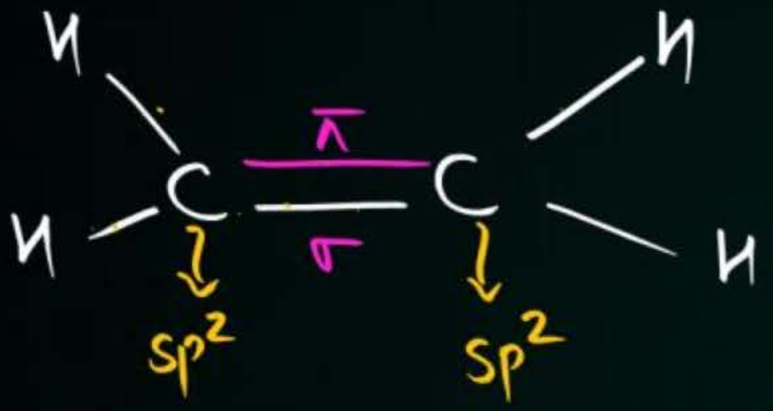


(One) C — O (σ)
$sp^3 - sp^3$

(three) C — H (σ)
$sp^3 - 1s$

(one) O — H (σ)
$sp^3 - 1s$

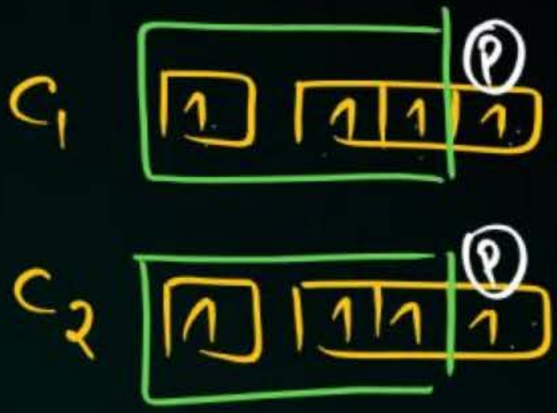
(7) $CH_2 = CH_2$

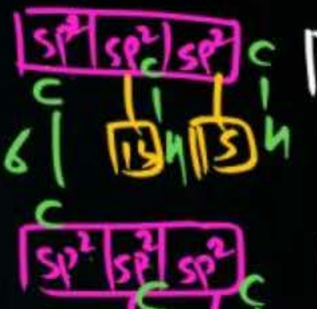


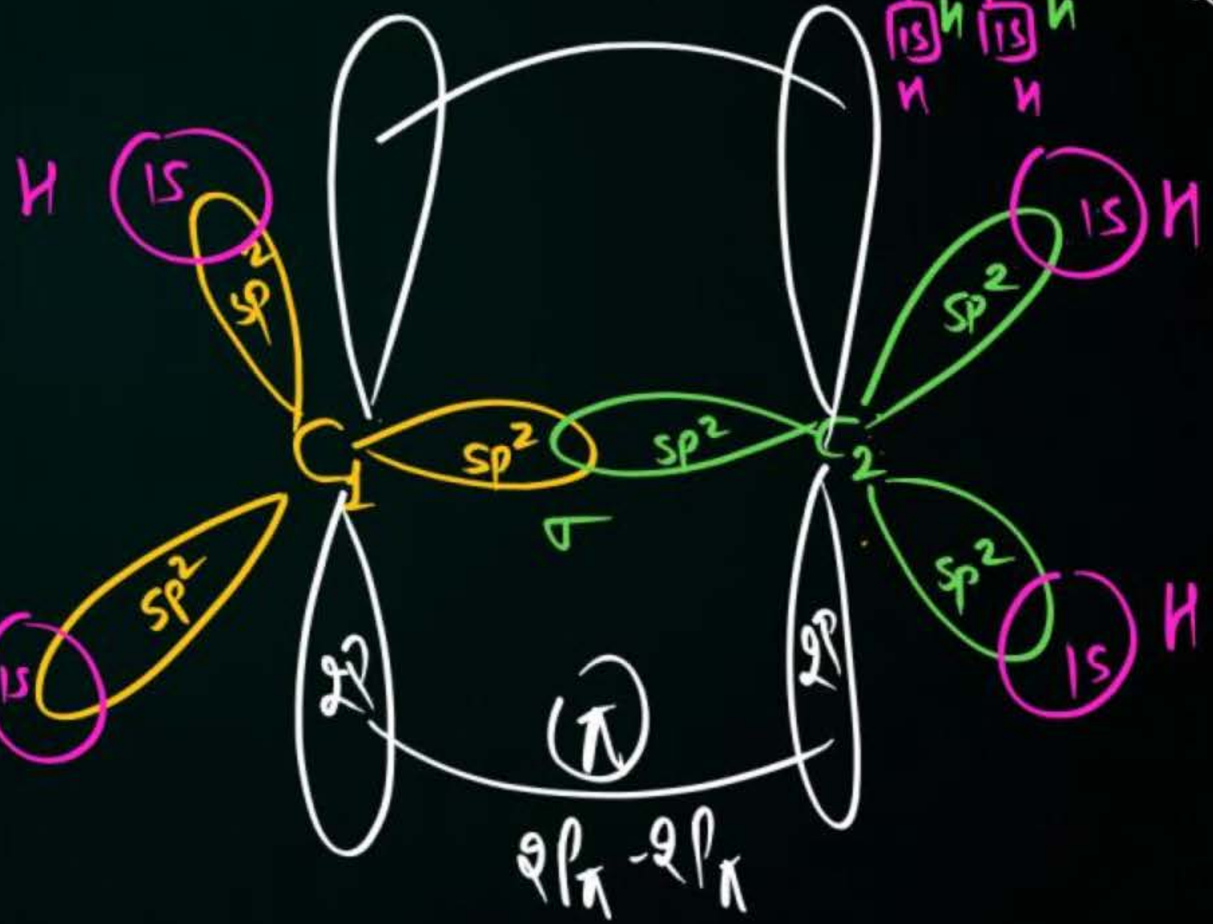
(one) σ $sp^2 - sp^2$ $(C \underset{\sigma}{-} C)$

(Four) σ $sp^2 - 1s$ $(C - H)$

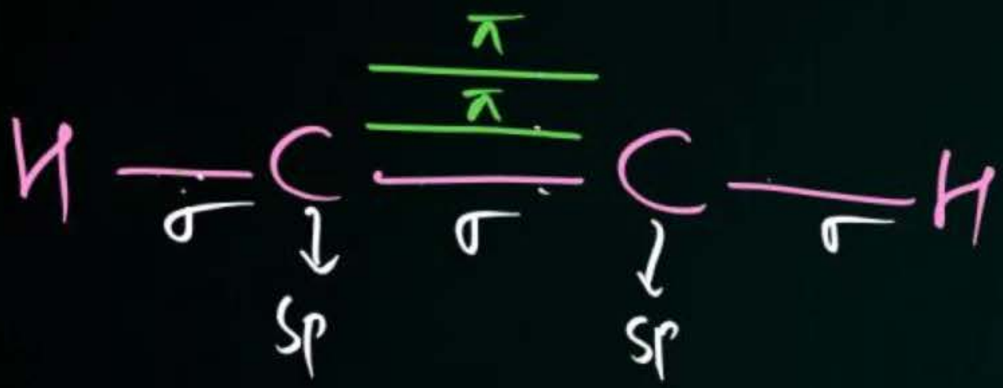
(One) π $2p - 2p$ $(C \underset{\pi}{-} C)$

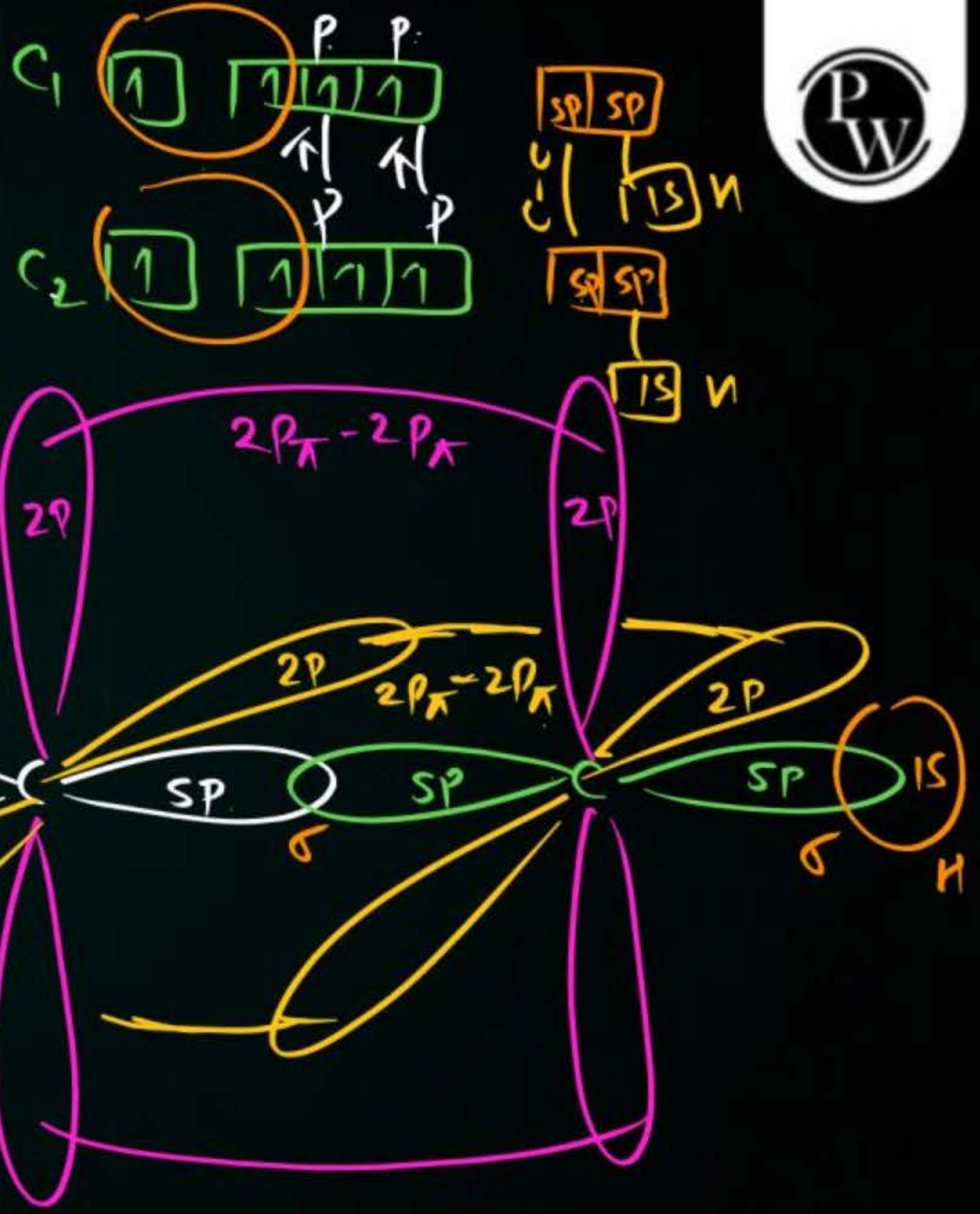






⑧ $CH \equiv CH$

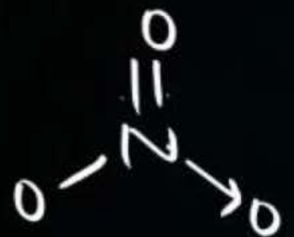



C1
C2
1
P
P
P
P
sp sp
C
C
1S H
sp sp
1S H
2p
2p
2p

MDJ For (π) identity

→ (i) if C.A belongs to 2nd Period then $p\pi - p\pi$ always

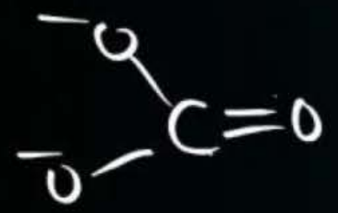
$\therefore$ ~~3d~~ ~~$d\pi$~~ ~~$f\pi$~~



SO_3^{2-} sp^3 AB_3L_1

NO_3^- $p\pi - p\pi$

NO_2^-



CO_3^{2-} $p\pi - p\pi$

$d\pi - p\pi$ ←

ClO_4^- sp^3 AB_4L_0

ClO_3^- sp^3 AB_3L_1

ClO_2^- sp^3 AB_2L_2

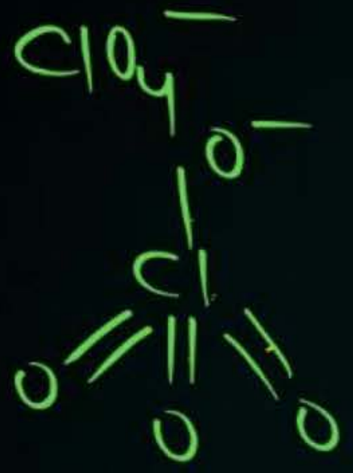
SO_4^{2-} sp^3 AB_4L_0

PO_4^{3-} sp^3

(ii) If Hybridisation is (sp) then all are $p\pi - p\pi$

(iii) If Hybridisation is sp^2 (s+p+p+p) then One is $p\pi - p\pi$ rest are $d\pi - p\pi$

(IV) If Hybridisation is (sp^3) or other all are $d\pi - p\pi$ (s+p+p+p)



sp^3

Three

$d\pi - p\pi$

ClO_3^-

sp^3

AB_3L_1

two $(d\pi - p\pi)$

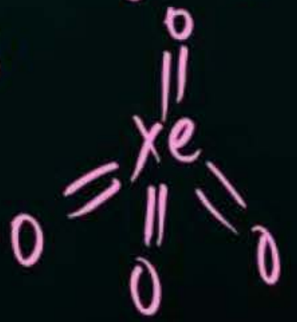
HW

ClO_2^-

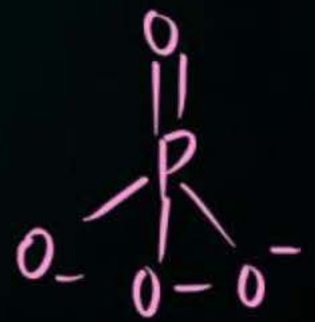
SO_3^{2-} sp^3

XeO_3 sp^3

NO_2^-



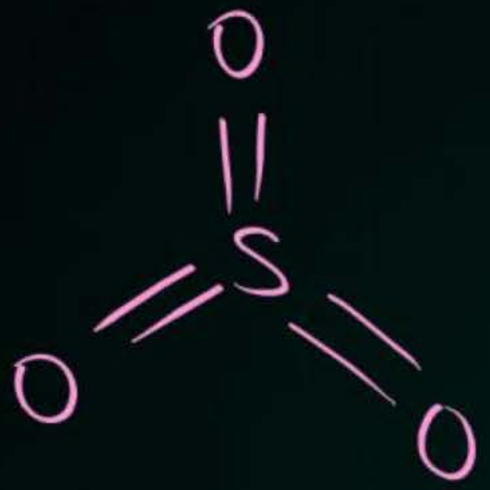
XeO_4 sp^3



SO_4^{2-} sp^3

PO_4^{3-} sp^3

SO_3



AB_3L_0 → sp^2 (s+p-hp) (p pure)

- One $p_\pi - p_\pi$
- Rest are $d_\pi - p_\pi$

} MDJ

Total $\pi = 3$

$p_\pi - p_\pi = 2$

$d_\pi - p_\pi = 2$

SO_2

AB_2L_1

sp^2

1 $P_\pi - P_\pi$

Rest are $d_\pi - P_\pi$

Total $\Rightarrow 2\pi$

One is $P_\pi - P_\pi$

One is $d_\pi - P_\pi$

QUESTION

$d\pi - p\pi$ or

Which of the following has $p\pi - d\pi$ bonding :

A NO_3^-

B SO_3^{-2}

C BO_3^{-3}

D CO_3^{-2}

Bond Strength :

(i) Bond strength $\propto \frac{1}{\text{size (shell no.)}}$ (P.Q.N)

1S–1S (n=1) > 2S–2S (n=2) > 3S–3S (n=3)

Size ↑ Strength ↓

* If size same : s-s < s-p < p-p 2S–2S < 2S–2P < 2P–2P

In Case of σ Bond (Co-axial) (B.S ∝ directional Nature)

* If size same : 3pπ-3pπ < 3pπ-3dπ < 3dπ-3dπ

In Case of π (Collateral) (B.S ∝ Extent of overlapping area)

(ii) Lone pair lone pair repulsion can show exceptions only in second period. elements & In Case of Single Bonded atoms

Ex (valid in) N–N O–O F–F

Compare Bond Strength in following :

i. 1s-1s > 2s-2s > 3s-3s

ii. 2s-2s < 2s-2p < 2p-2p (directional nature)

iii. 1s-2s < 1s-2p (size same, B.S ∝ directional nature)

iv. p-p (Co-axial) > p-p(collateral)

v. N-N < P-P

vi. O-O < S-S

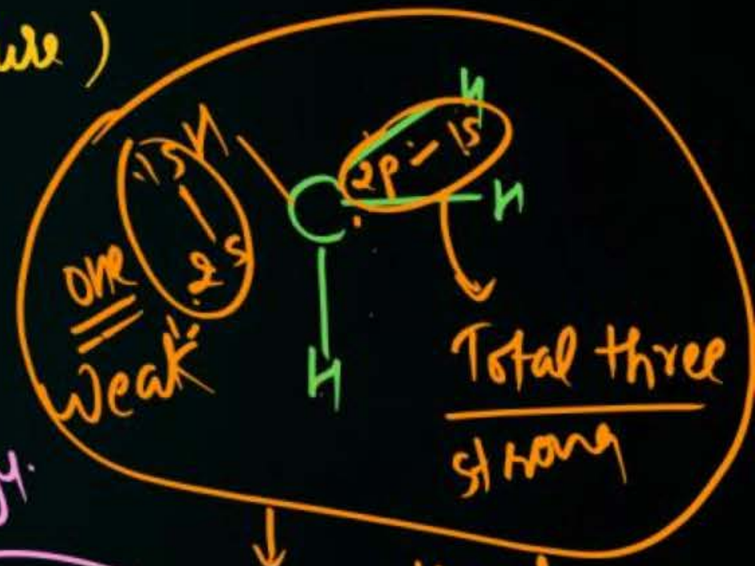
vii. F-F < Cl-Cl > Br-Br > I-I

l.p - l.p repulsion

Very. V. Imp

Bond strength or Bond Energy ↑

$Cl_2 > Br_2 > F_2 > I_2$



CH_4 without Hybridisation

Size same

	①			⑤
viii.	1s-1s	2s-2s	2s-2p	2p-2p	3s-3s
		④	③	②	
ix.	3pπ-3pπ	< 3pπ-3dπ	< 3dπ-3dπ		
		③	②	④	
x.	2pπ-2pπ	3pπ-3dπ	3dπ-3dπ	3pπ-3pπ	
	①				

same size

Weakest

Exist

1 > 2 > 3 > 4 > 5

N ≡ N

✓ Exist

✓ $2p_\pi - 2p_\pi$ strong

P ≡ P

Exist

∵ $3p_\pi - 3p_\pi$ Exist

QUESTION

Nitrogen form N_2 but phosphorous do not exist as P_2, at room temp. because :

(A) Triple bond present between phosphorous atom

(B) $p_\pi - p_\pi$ bonding is weak

(C) $p_\pi - p_\pi$ bonding is strong

(D) Multiple bond form easily

Homework

give Correct order of Bond strength in following

1. C-C Si-Si Ge-Ge Sn-Sn
2. C-C C=C C≡C
3. N-N N=N N≡N
4. C=N C≡N
5. C=O C≡O
6. O-O O=O
7. H-F H-Cl H-Br H-I

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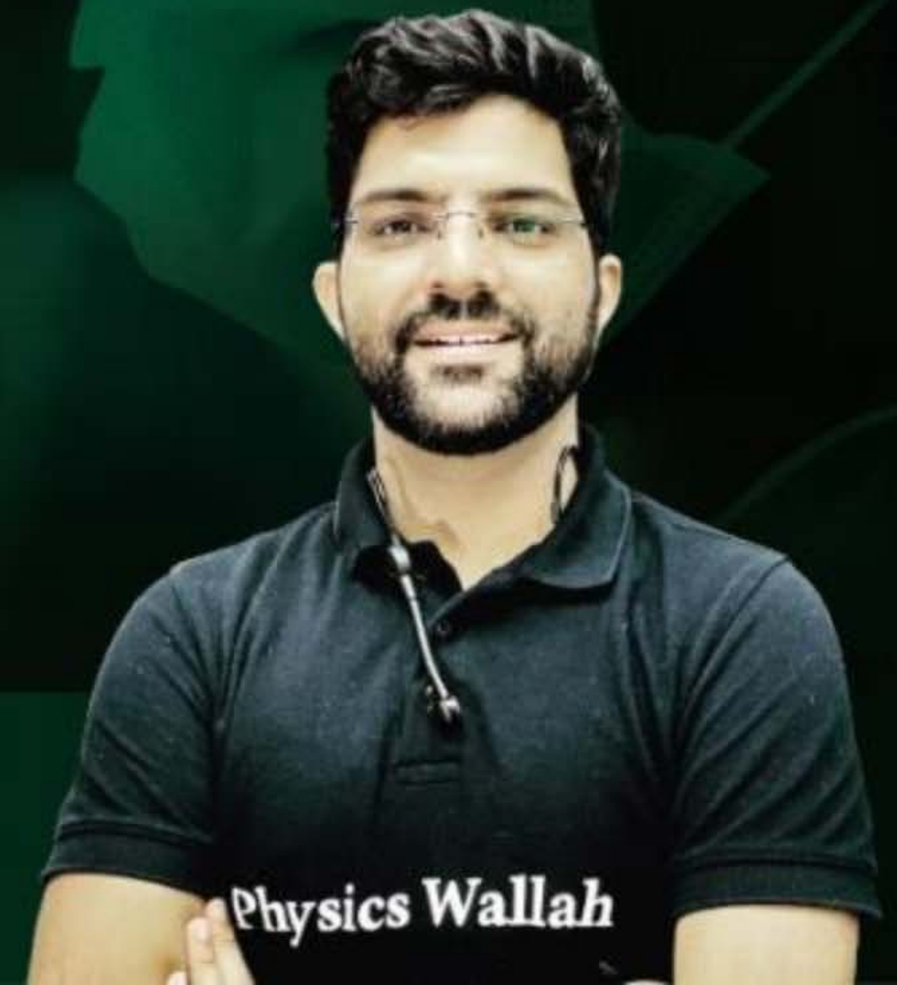
FOR NEET 2025

Lecture - 08 | Inorganic Chemistry

Chemical Bonding & Molecular Structure

By - Mohit Dadheech (MD Sir)



Topics *to be covered*

1. Bond Parameters
   - Bond length
   - Bond Enthalpy
   - Bond angle
   - Bond order

Bond Parameters :

Experimental Data

1. Bond Length

Inter Nuclear Distance

- Bond length is defined as the equilibrium distance between the nuclei of two bonded atoms in a molecule.

- The covalent radius is measured approximately as the radius of an atom's core which is in contact with the core of an adjacent atom in a bonded situation.

- The van der Waals radius represents the overall size of the atom which includes its valence shell in a nonbonded situation.

O > N > O > F (Size)

Bond Type	Covalent Bond Length (pm)
O–H	96
C–H	107
N–O	136
C–O	143
C–N	143
C–C	154 ✓
C=O	121
N=O	122
C=C	133 ✓
C=N	138
C≡N	116
C≡C	120 ✓

C (C–C) (C=C) C≡C (B.L)

Molecule	Bond Length (pm)
H_2 (H – H)	74
F_2 (F – F)	144 ✓
Cl_2 (Cl – Cl)	199 ✓
Br_2 (Br – Br)	228 ✓
I_2 (I – I)	267 ✓
N_2 (N ≡ N)	109
O_2 (O = O)	121
HF (H – F)	92
HCl (H – Cl)	127
HBr (H – Br)	141
HI (H – I)	160

N_2: 3.0, 3.0 — O_2: 2.0, 3.0

HF < HCl < HBr < HI (B.L)

F_2 Cl_2 Br_2 I_2 (Bond strength / Bond Energy)

$Cl_2 > Br_2 > F_2 > I_2$

F_2 → l.p-l.p repulsion

But

$F_2 < Cl_2 < Br_2 < I_2$ (Bond length)

B.O = 2

2. Bond Order

- In the Lewis description of covalent bond, the Bond Order is given by the number of bonds between the two atoms in a molecule.

- Isoelectronic molecules and ions have identical bond orders; for example, F_2 and O_2^{2-} have bond order 1. N_2, CO and NO^+ have bond order 3.

18e⁻ 14e⁻, 14e⁻, 14e⁻ 18e⁻

- A general correlation useful for understanding the stablities of molecules is that: with increase in bond order, bond enthalpy increases and bond length decreases.

gen

$$B.O \propto B.S \propto \frac{1}{B.L}$$

CO
6 + 8 = 14 e⁻

CN⁻
6 + 7 + 1 = 14 e⁻

Isoelectronic

3. Bond Enthalpy

- It is defined as the amount of energy required to break one mole of bonds of a particular type between two atoms in a gaseous state.

- In case of polyatomic molecules, the measurement of bond strength is more complicated. For example in case of H_2O molecule, the enthalpy needed to break the two O – H bonds is not the same.

- Therefore in polyatomic molecules the term mean or average bond enthalpy is used. It is obtained by dividing total bond dissociation enthalpy by the number of bonds broken.

$H_2O \longrightarrow H + OH \quad 502\ kJ\,mol^{-1}$

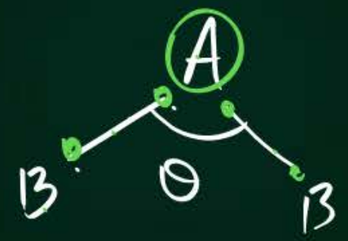
$OH \longrightarrow H + O \quad 427\ kJ\,mol^{-1}$

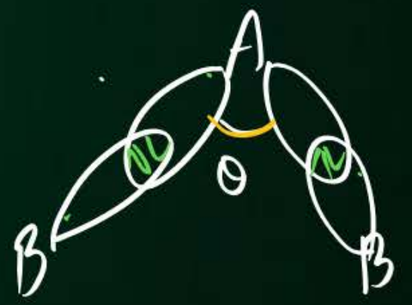
Avg $\dfrac{502 + 427}{2}$

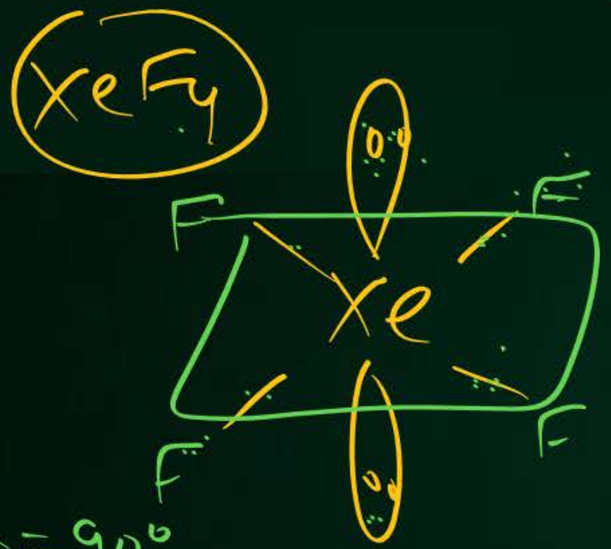
$464.5\ kJ\,mol^{-1}$

2. Bond Angle

- It is defined as the angle between the orbitals containing bonding electron pairs around the central atom in a molecule/complex ion. Bond angle is expressed in degree which can be experimentally determined by spectroscopic methods.





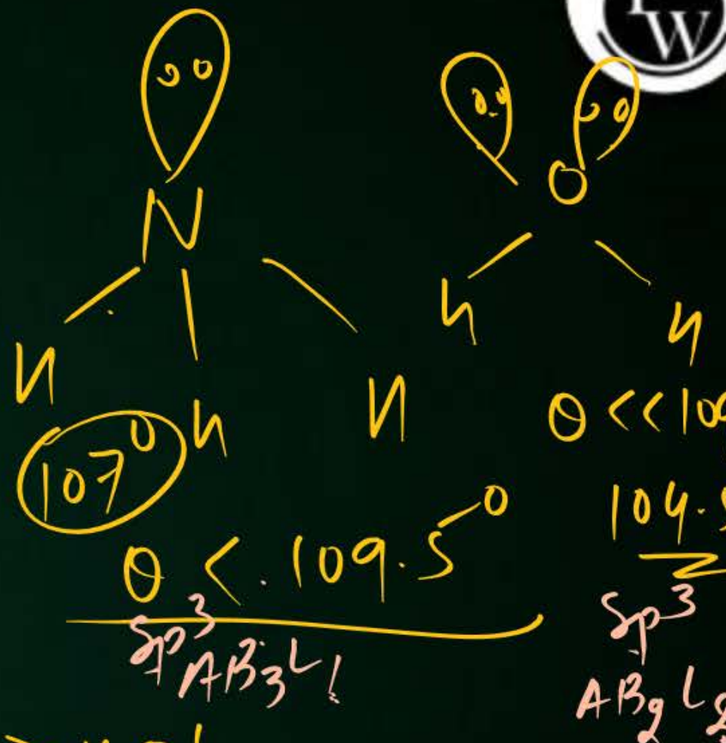


adj. $\theta = 90^\circ$

109.5°

sp^3

AB_4L_0



$\theta < 109.5^\circ$

sp^3

AB_3L_1

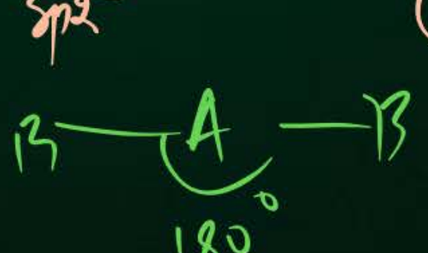
sp^3

AB_2L_2

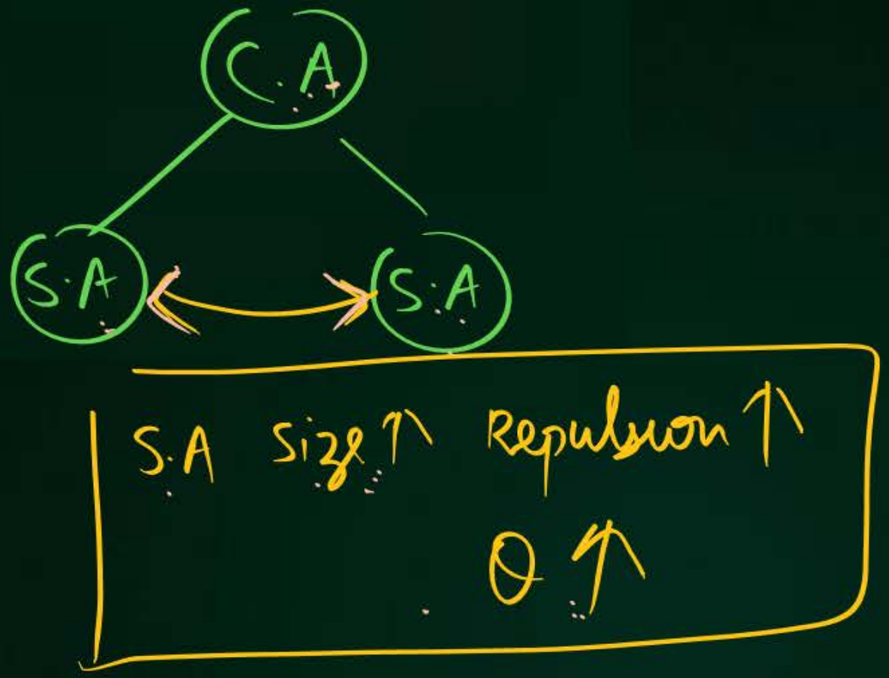
$CO_2 > BF_3 > CH_4 > NH_3 > H_2O$

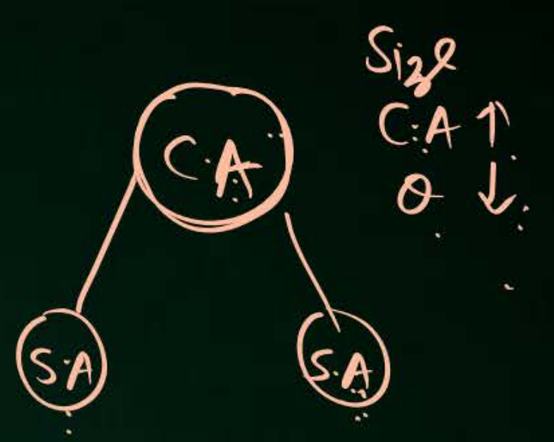
sp sp2 sp3

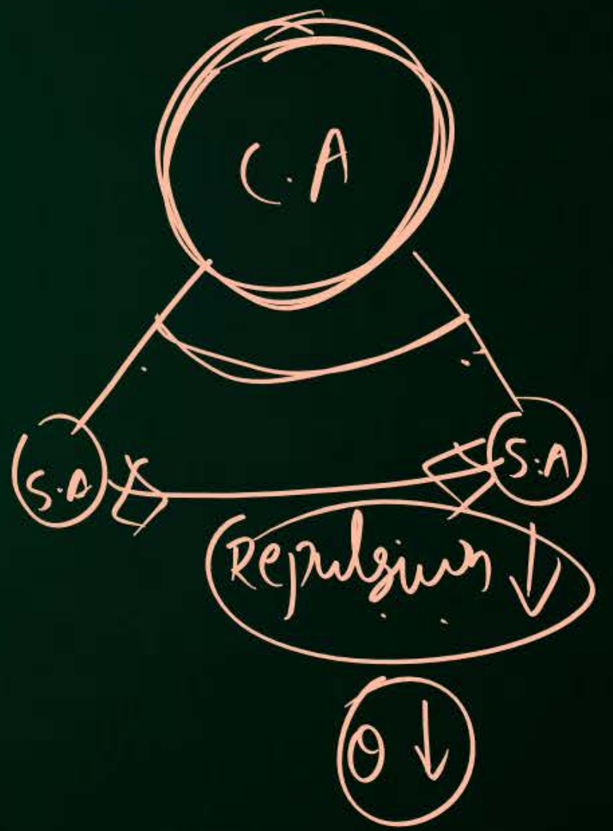
All possible $\theta =$ 90 & 180°



linear


C.A
S.A
S.A
S.A size ↑ Repulsion ↑
θ ↑


Size
C.A ↑
θ ↓
C.A
S.A
S.A


C.A
S.A
S.A
Repulsion ↓
θ ↓

Bond Angle :

Step by step

MDI

Trick to find Bond Angle

VSEPR → Shape → linear Max θ = 180°

→ AB_2L_0 , AB_2L_3

Hybridisation $SP > sp^2 > sp^3$ (% s)

$180° > 120° > 109.5°$ s ↓ θ ↓

If Hybridisation is same

l.p lagao Angle ghatao

If lone pair is present at central atom

No. of L.P. ↑ Bond angle ↓

If L.P. and hybridisation both are same

- Size of surrounding atom ↑ bond angle ↑
- Size of central atom ↑ bond angle ↓

If lone pair is absent at central atom

Give answer acc. to hybridisation

$BF_3 = BCl_3 = BBr_3$

AB_3L_0, sp^2

Q Compare Bond Angle in Following Species :-

(1) $CO_2 = XeF_2$

AB_2L_0 — linear

AB_2L_3 — linear

(2) $CS_2 > SO_2$

CS_2: AB_2L_0, linear

SO_2: AB_2L_1, Bent

(3) BF_3 CO_2 CH_4

BF_3: AB_3L_0, sp^2

CO_2: AB_2L_0, sp

CH_4: AB_4L_0, sp^3

$CO_2 > BF_3 > CH_4$

(Imp) (4) $CH_4 > NH_3 > H_2O$

CH_4: sp^3, AB_4L_0

NH_3: sp^3, AB_3L_1

H_2O: sp^3, AB_2L_2

⑤ $CCl_4 = SiCl_4$

AB_4L_0, sp^3

Hyb same

l·p absent at C·A

~~C·A~~ ~~O·A~~

⑥ $CO_2 > SiO_2$

Special case →

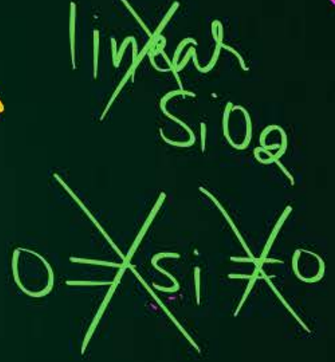
SiO_2

All 4 "O" are shared.

3D Silicate

linear

SiO_2



tetrahedral

109.5°

CO_2

(7) $NF_3 < NCl_3 < NBr_3$

AB_3L_1, sp^3

Hyb same
no. of l.p same
C.A same.
S.A ↑ θ ↑

(8) NCl_3 PCl_3 $AsCl_3$

AB_3L_1, sp^3

C.A diff C.A ↑ θ ↓

Hyb same.
no. of l.p same
S.A same.

QUESTION

Correct order of bond angle is / are :

1. $SO_2 = CO_2$ ✗

2. $NO_2^- > NO_2^+$ ✗

Bent AB_2L_1 — linear AB_2L_0

3. $NO_3^- < N_3^-$

AB_3L_0 — AB_2L_0 linear

$120^\circ < 180^\circ$

4. $CH_4 < NH_4^+$ ✗

AB_4L_0 sp^3 — AB_4L_0 sp^3

$CH_4 \equiv NH_4^+$

QUESTION

In which of the following change, adjacent bond angle increases?

1. $BeF_2 + 2F^- \longrightarrow BeF_4^{2-}$
   AB_2L_0 180° → AB_4L_0 109.5°
2. $SiF_4 + 2F^- \longrightarrow SiF_6^{2-}$
   AB_4L_0 109.5° → AB_6L_0 90°
3. $BF_3 + F^- \longrightarrow BF_4^-$
   AB_3L_0 120° → AB_4L_0 109.5°
4. $NH_3 + H^+ \longrightarrow NH_4^+$
   AB_3L_1 107° → AB_4L_0 109.5°

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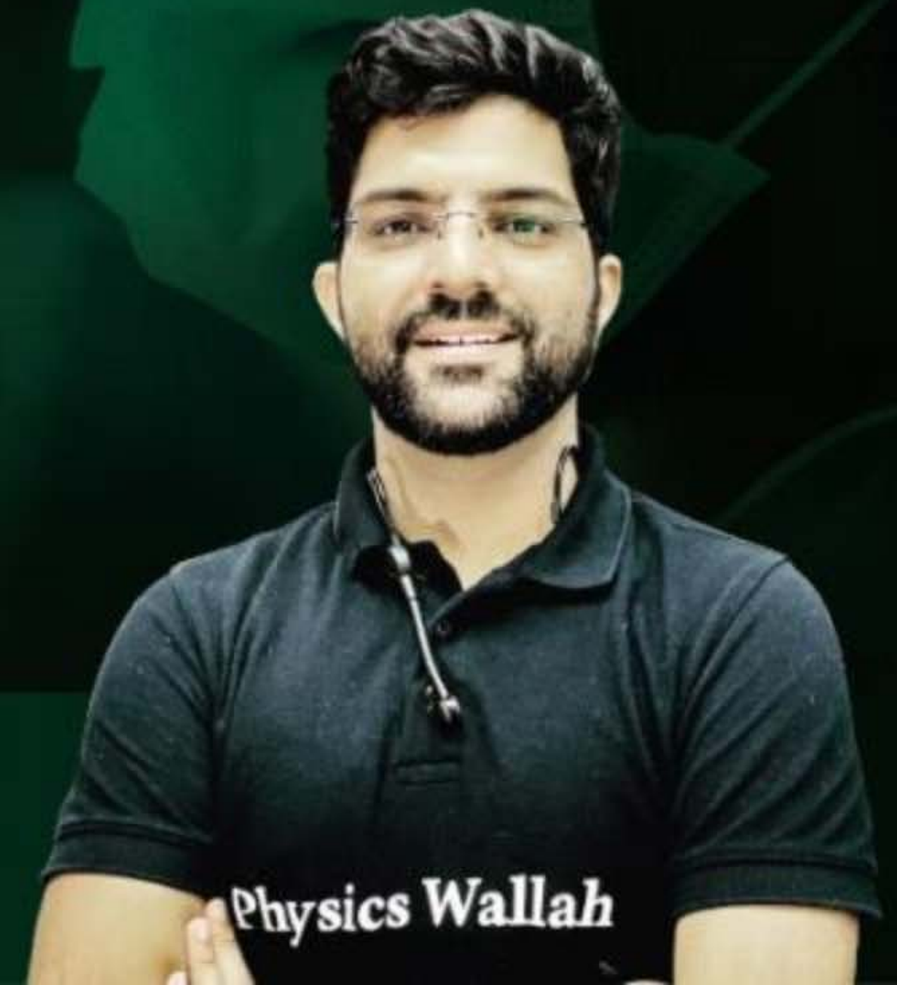
FOR NEET 2025

Lecture - 09 | Inorganic Chemistry

Chemical Bonding & Molecular Structure

By - Mohit Dadheech (MD Sir)



Topics *to be covered*

1. Some Important Points

Some Important Points

- Hybridisation in odd e^- species
- Existing & Non-Existing molecules
- Solid state hybridisation in some important species

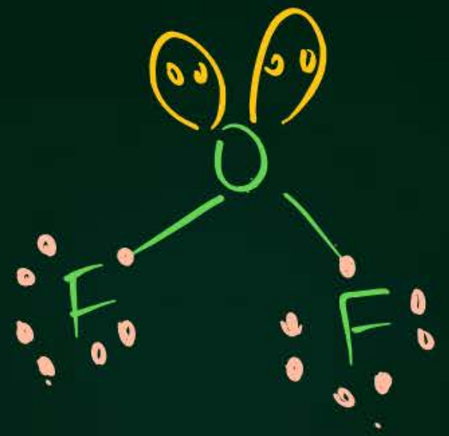
Not in NCERT

OF_2 Total l.p & B.p

Total

B.p → σ + π

l.p → All atoms



Total l.p = 8

Total B.p → σ + π
2 + 0 = 2

σ Bond

AB_2L_2 → l.p at Central atom

Central atom

I_3^-

Total l.p

9

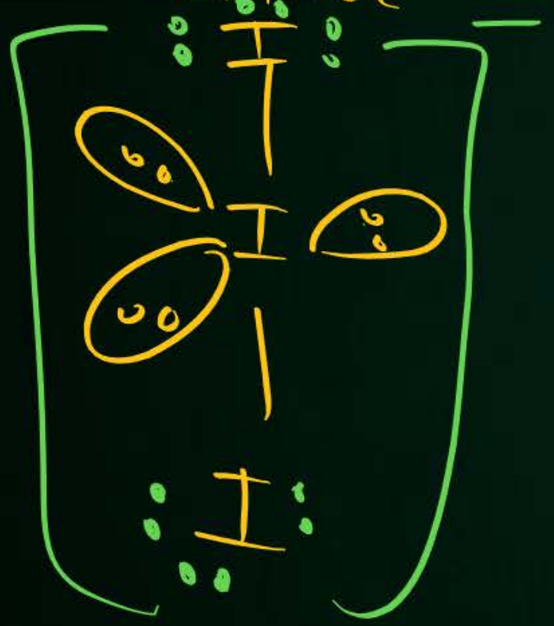
l.p at Central atom

3

JEE Mains

AB_2L_3

linear



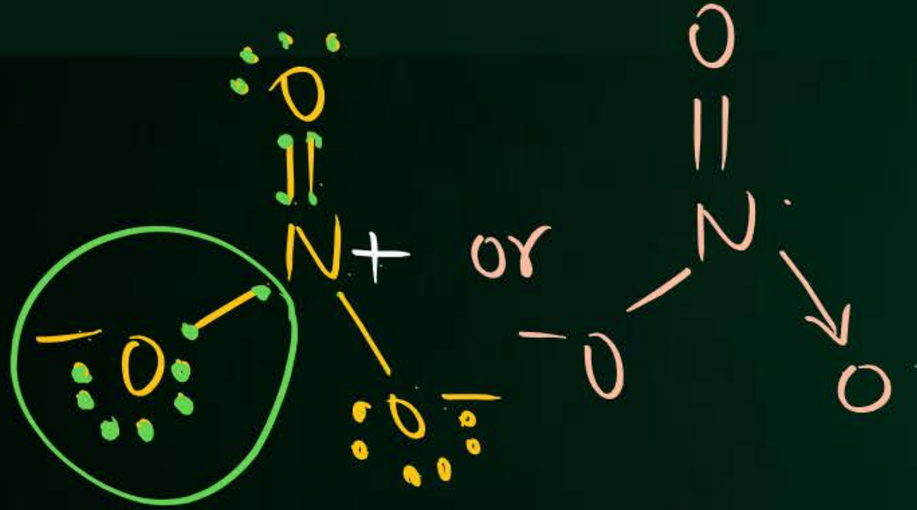
NO_3^-

Total l.p

Total B.p ($\sigma + \pi$)

l.p at Central atom

AB_3L_0



8

$3\sigma + 1\pi$

4

0

$-2+1=(-1)$

Q. How many Bond pair & l.p are present in NO_3^- respectively

1. 3, 0
2. 3, 1
3. 5, 8
4. 2, 2

Hybridisation in some important odd e⁻ species

Orbital having odd e⁻ can participate in hybridisation only when surrounding atom is high EN.

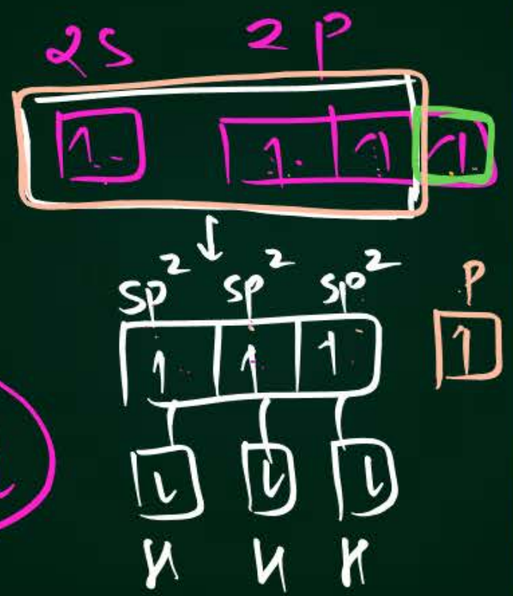
Ex. CH_3

sp^3 ~~sp^3~~

sp^2

T. planar

~~Tetra~~



Q In CH_3 odd e⁻ present in

(1) sp^3 H.O.

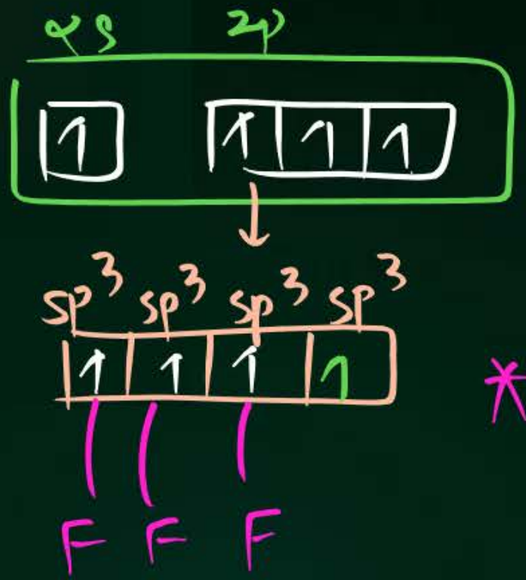
(2) sp H.O.

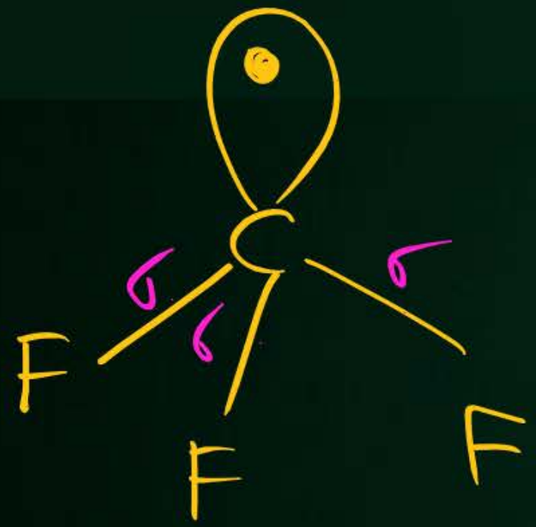
(3) sp^2 H.O.

(4) Pure "p" orbital.

S.A ⇒ F High EN

Ex.2 CF_3



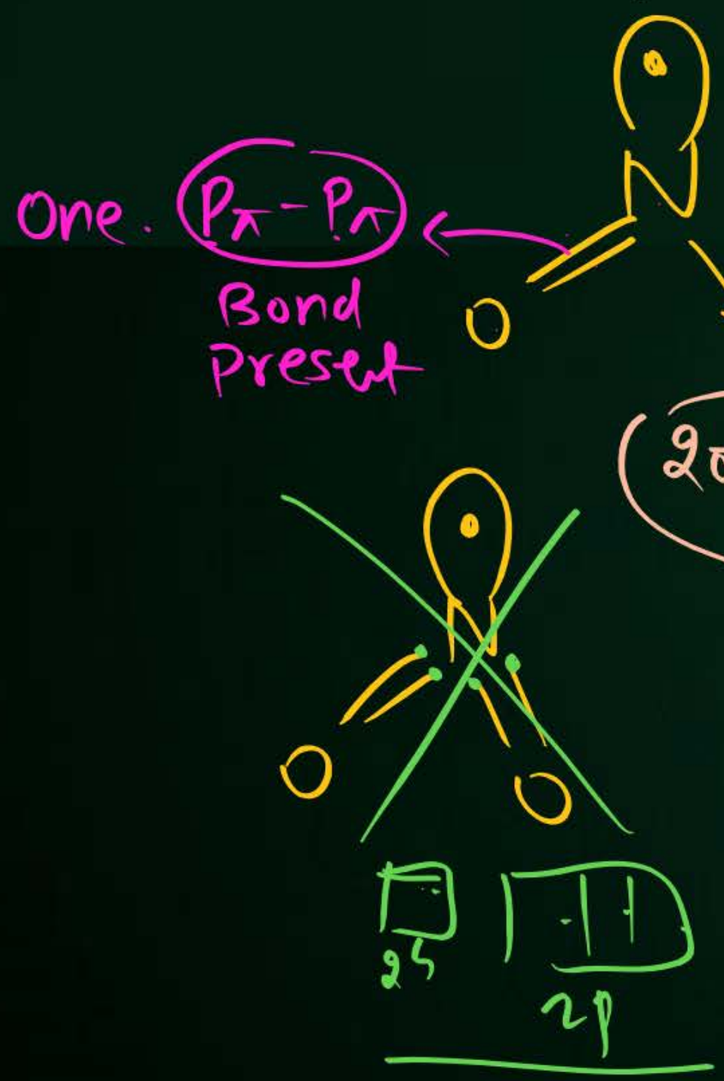


Trigonal pyramidal

$3\sigma + 1$ odd e^- orbital $= (4) \rightarrow sp^3$

* Odd e^- in CF_3 is present in sp^3 Hybrid orbital.

Ex. 3 NO_2



$2\sigma + 1$ odd $\bar{e}$ $\rightarrow$ sp^2, Bent.

– 1σ Coordinate present

– Acidi oxide $\rightarrow$ Can Cause Acid Rain

$\overset{+4}{N}O_2 + H_2O \rightarrow \overset{+2}{N}O + H\overset{+5}{N}O_3$

$O-\hat{N}-O$ Bond Angle in NO_2

$\theta = 134^\circ$.

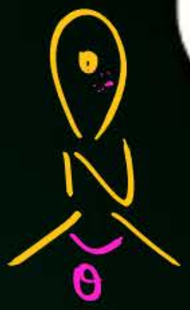
Bond Angle order :-

$NO_2^+ > NO_2 > NO_3^- > NO_2^-$

$180^\circ \quad 134^\circ \quad 120^\circ \quad \theta < 120^\circ$

$\theta = 120^\circ$

$\theta < 120^\circ$



$120 < \theta < 180$

$\simeq 134^\circ$.

Hybridisation of some molecules in solid state

Imp

$PCl_5(s) \longrightarrow PCl_4^+ + PCl_6^-$

$PBr_5(s) \longrightarrow PBr_4^+ + Br^-$

$N_2O_4(s) \longrightarrow NO^+ + NO_3^-$

$N_2O_5(s) \longrightarrow NO_2^+ + NO_3^-$

$XeF_6(s) \longrightarrow XeF_5^+ + F^-$

NOT in NCERT

$PCl_{5(s)} \longrightarrow \underbrace{PCl_4^+}_{\text{Cation}} + \underbrace{PCl_6^-}_{\text{Anion}}$ (Bond: Ionic)

Cation: AB_4L_0, Tetra, sp^3

Anion: AB_6L_0, Octa, sp^3d^2

Existing & Non-Existing molecules

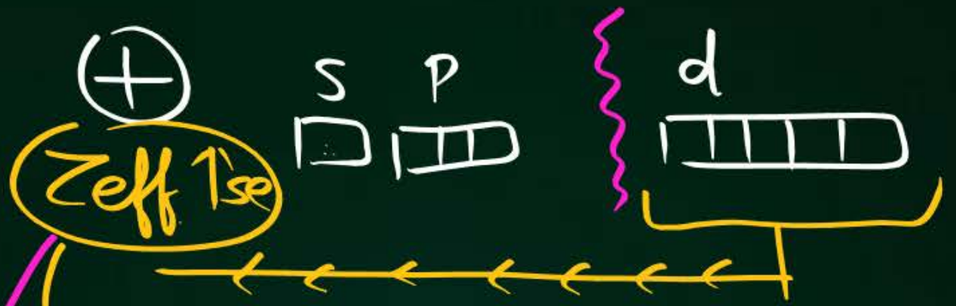
Improper Covalency ✓
Steric hindrance ✓
non contracted d orbitals
Non existance

(A) Non-contraction of d-orbitals

Existing		Non-Existing	
XeF_6	sp^3d^3	XeH_6	X sp^3d^3
XeF_2	sp^3d	XeH_2	sp^3d
SF_6	sp^3d^2	SH_6	sp^3d^2

then

If central atom have to use its d-orbitals in hybridisation, they must be sufficiently contracted it is only possible when surrounding atom in high EN.



Contraction 1se

Energy gap ↓se

easy mixing of d orbital

when

S.A high EN

+δ

C.A → +s ↑

Zeff ↑

∴ S.A EN ↑

Existing & Non-Existing molecules

Max Covalency of 2nd period is → 4

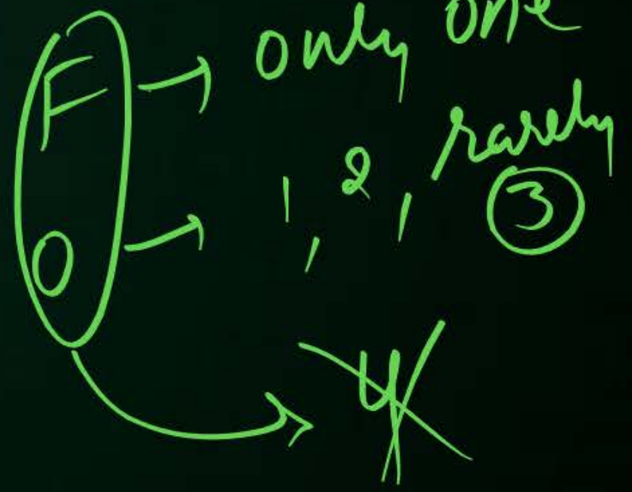
(B) Improper covalency

Existing

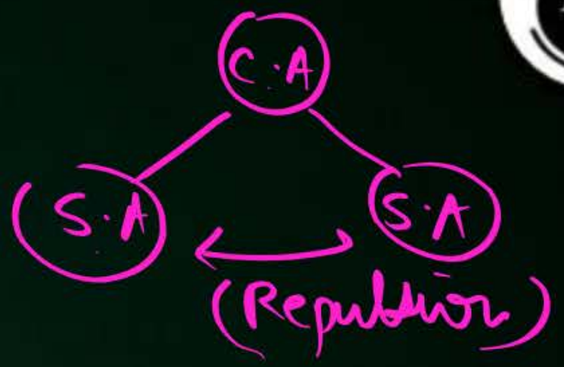
- NCl_3
- BF_4^-
- ClF_3

Non-Existing

- NCl_5
- BF_6^{3-}
- FCl_3



Existing & Non-Existing molecules



(C) Steric Hindrance

Existing

- PCl_6^-
- SiF_6^{2-}
- IF_7

Non-Existing

- PBr_6^- (Br size large)
- $SiCl_6^{2-}$
- ICl_7

IBr_7

Some Imp Point :-

MDJ 1 ⇒ Multiple Bond & l.p Bhai-Bhai

(=/≡) (🙂)

that means Multiple bonds occupy - positions in structure Same as l.p

① In T-B-P geometry

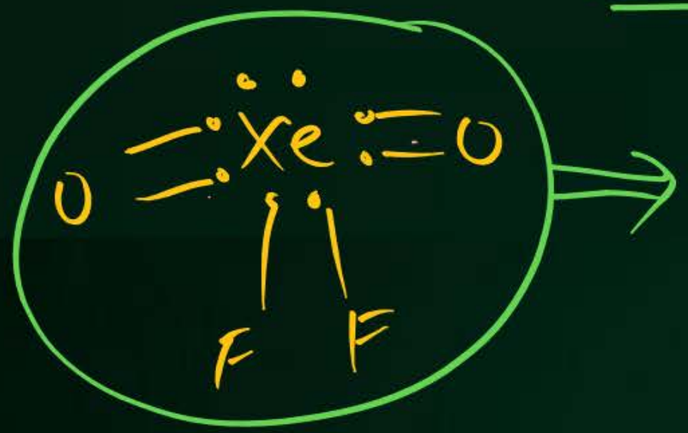
l.p → equatorial

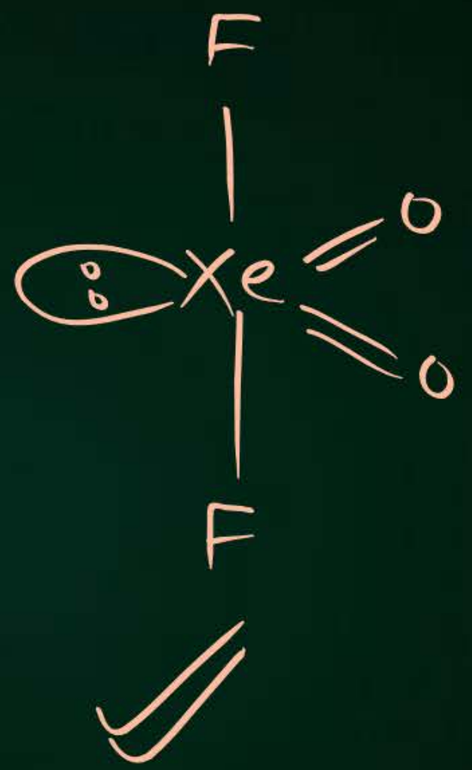
Multiple Bond → equatorial.

Ex XeO_2F_2

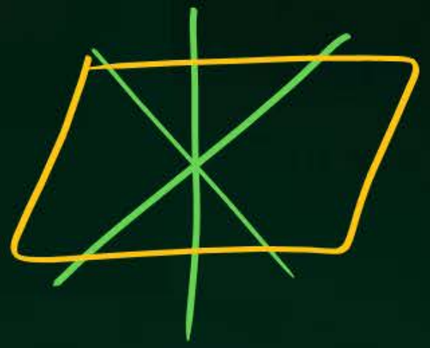
AB_4L_1

seesaw





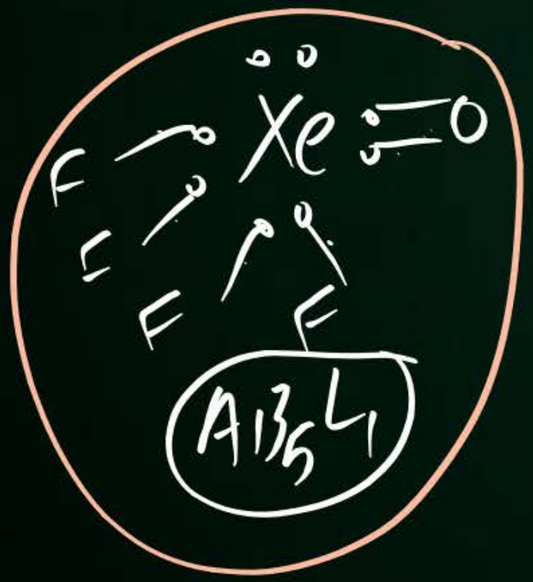
(2) In S.B.P / octahedral parent geometry



1st l.p / Multiple Bond
↓
at Any Position

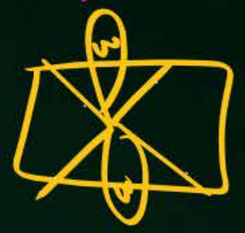
2nd l.p / Multiple Bond
↓
opposite to each other

(Ex) $XeOF_4$



⇒ geometry in which Zero effect of l.p on Bond Angle

Sq. planar. AB_4L_2



$\theta = 90°$

linear AB_2L_3

$\theta = 180°$

Pentagonal Planar - AB_5L_2

$\theta = 72°$

QUESTION

Molecule which does not contain any F–X–F bond angle which is less than 90° ? (X = central atom)

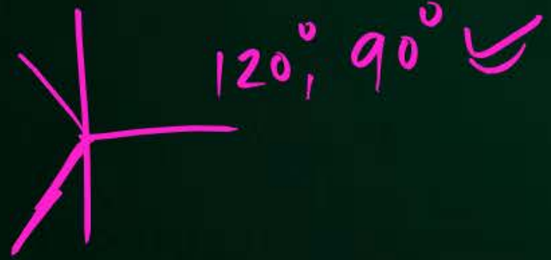
1. IF_7 AB_7L_0

$\theta = 72°$

2. BrF_3 AB_3L_2 Bent T

$\theta < 90°$

3. PF_5



120°, 90°

$\theta < 90°$

4. SF_4 AB_4L_1 See saw

QUESTION

These is not effect of lone pair on bond angle in :

1. XeF_2, ICl_4^-

2. BF_3, OF_2

3. IF_5, NH_3

4. I_3^-, I_3^+

QUESTION

The bond angle around central atom in highest in :

1. BBr_3 AB_3L_0 T-planar 120°
2. CS_2 AB_2L_0 linear 180°
3. SO_2 AB_2L_1 Bent $\theta < 120^\circ$
4. SF_4 AB_4L_1

QUESTION

Set of planar species having same hybridization and same bond angle :

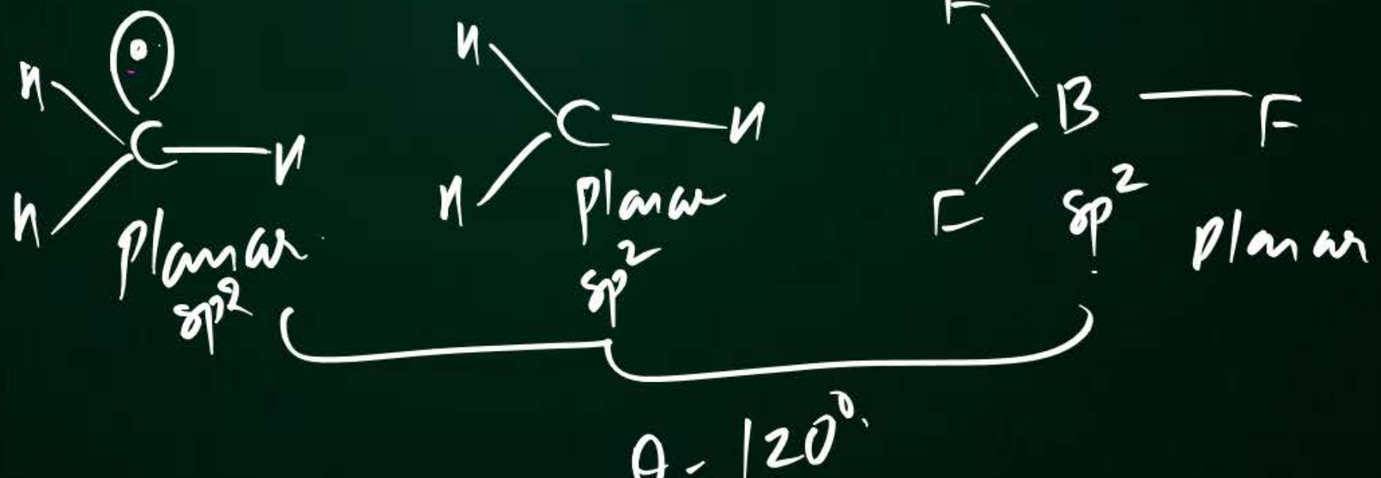
AB_4L_0 tetra

1. CH_4, BF_3, NH_3

2. CH_4, BF_4^-, NH_4^+

3. $\dot{C}H_3$, $\overset{+}{C}H_3$, BF_3

4. $\dot{C}F_3$, $\overset{+}{C}F_3$, SO_3



QUESTION

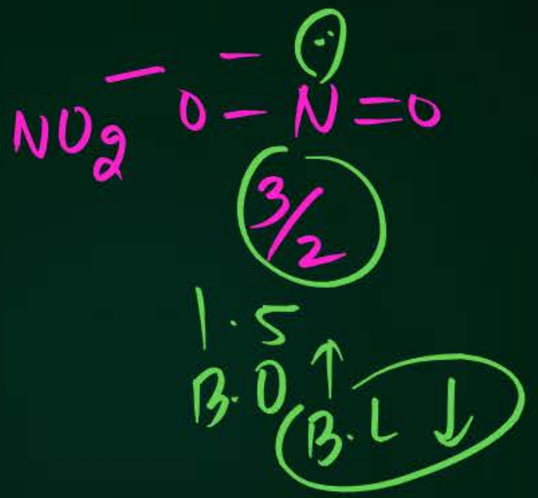
Which of the following order is not correct ?

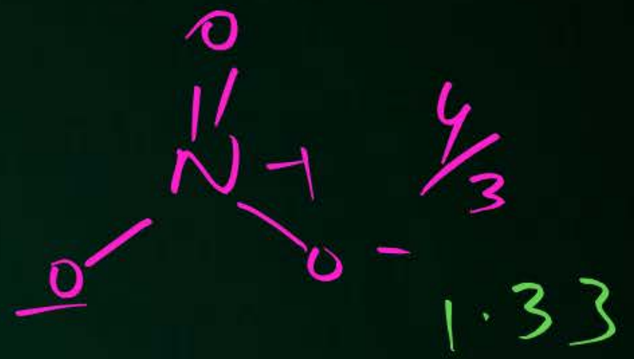
1. NO_2^- > NO_3^- bond order

2. NO_2^- > NO_3^- bond angle

3. NO_2^- > NO_3^- formal charge on terminal oxygen

4. NO_2^- > NO_3^- bond length





QUESTION

PCl_4^+ , PCl_6^-

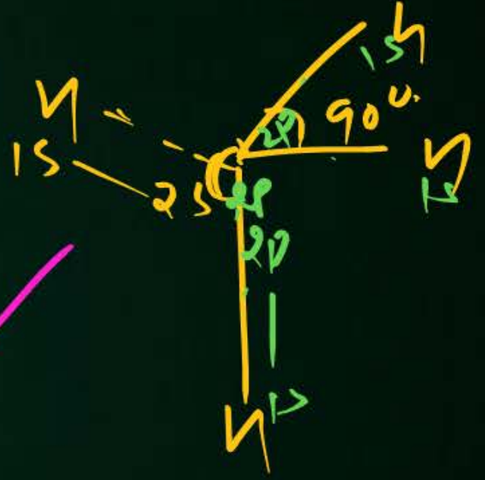
$PCl_5(s)$ contain following species :

1. Trigonal bipyramidal only
2. Square pyramidal & tetrahedral
3. Tetrahedral & octahedral
4. Tetrahedral & pyramidal

QUESTION

CH_4 without Hybridisation

Assuming pure 2s and 2p orbitals of carbon are used in forming CH_4 molecule, which of the following statement is false ?

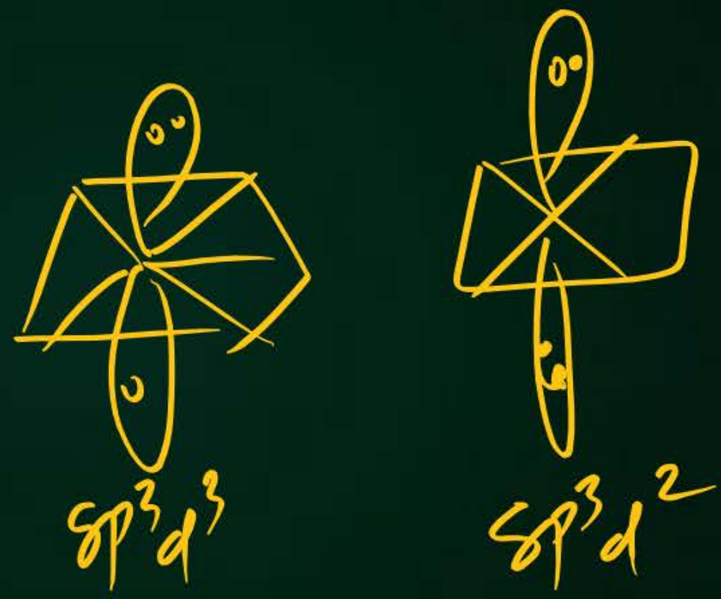


1. Three C–H bonds will be at right angle ✓
2. One C–H bond will be weaker than other three C–H bonds ✓
3. The shape of molecule will be tetrahedral ✗
4. The angle of C–H formed by s-s overlapping will be uncertain with respect to other three bonds. ✓

QUESTION

In which of the following hybridisation, lone pairs are observed on opposite position ?

1. sp^3d
2. sp^3d^2
3. sp^3d^3
4. Both (2) and (3)



Homework

From Module - 1

Questions Based on
- Shape
- Hybridisation
- Bond Angle
- overlapping

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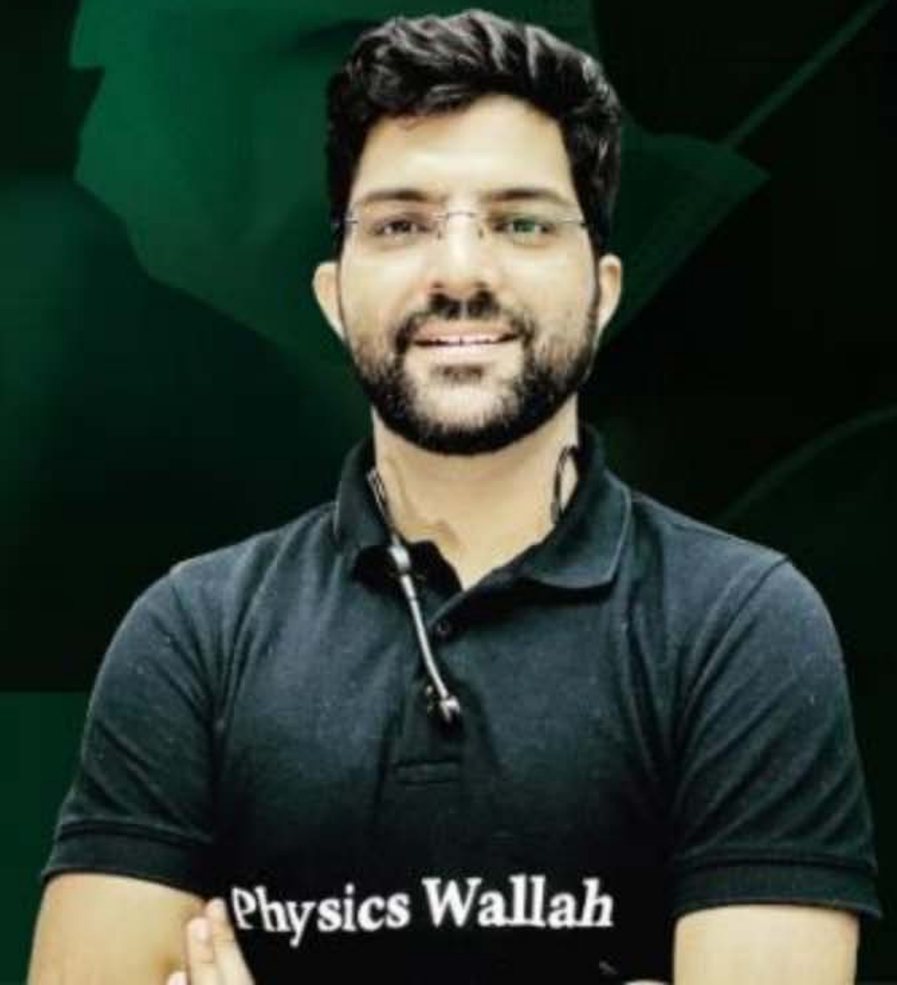
FOR NEET 2025

Lecture - 10 | Inorganic Chemistry

Chemical Bonding & Molecular Structure

By - Mohit Dadheech (MD Sir)



Topics *to be covered*

1. Dipole Moment

H.W

Lec-6

Ans

		d-orbitals used.	d orbitals remains Pure.
XeF_4	AB_4L_2 sp^3d^2	$d_{z^2}, d_{x^2-y^2}$	d_{xy}, d_{yz}, d_{xz}
IF_7	AB_7L_0 sp^3d^3	$d_{z^2}, d_{x^2-y^2}, d_{xy}$	d_{yz}, d_{xz}
ICl_2^-	AB_2L_3 sp^3d	d_{z^2}	$d_{x^2-y^2}, d_{xy}, d_{yz}, d_{xz}$
XeF_2	AB_2L_3 sp^3d	—	— 4 — —
ClF_3	AB_3L_2 sp^3d	—	— — 4 — —

27. Which of the following order is not correct ?

(A) $NO_2^- > NO_3^-$ bond order ✓

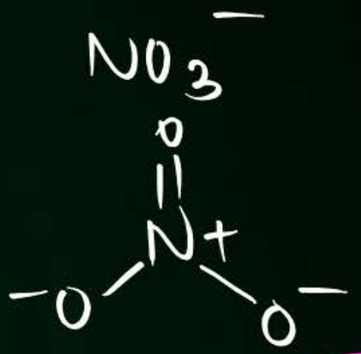
(B) $NO_2^- < NO_3^-$ bond angle ✓

(C) $NO_2^- < NO_3^-$ formal charge on terminal oxygen ✓

(D) $NO_2^- > NO_3^-$ bond length ✗

$\theta < 120$

$\theta = 120°$



Avg Bond order. $\frac{3}{2} = 1.5$

$\frac{4}{3} = 1.33$

Bond length. $NO_2^- < NO_3^-$

Avg F.C $-\frac{1}{2} = -0.5$

$-\frac{2}{3} = -0.66$

Correct order of Bond lengths :—

B—F < B—Cl

(1) BF_4^- < BF_3 X

sp^3 sp^2

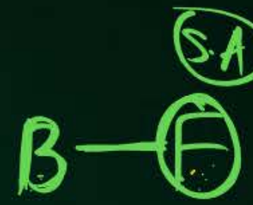
(2) NO_2^+ < NO_2^-

sp sp^2

(3) CCl_4 < CF_4 X C—Cl > C—F

(4) $\overset{+}{C}H_3$ > CH_4 X

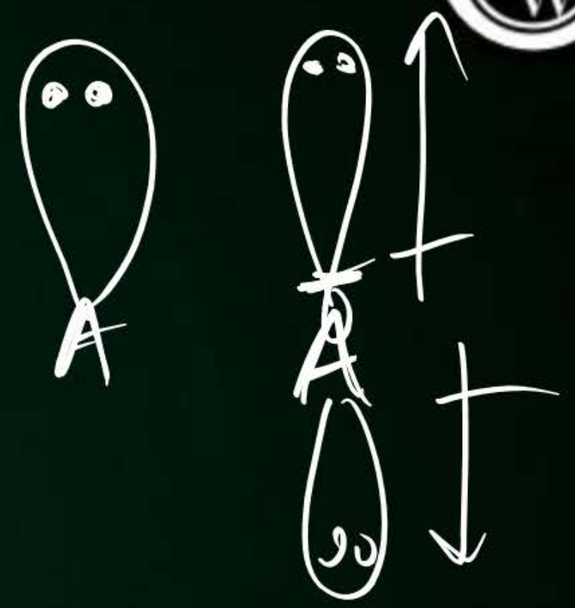
sp^2 sp^3



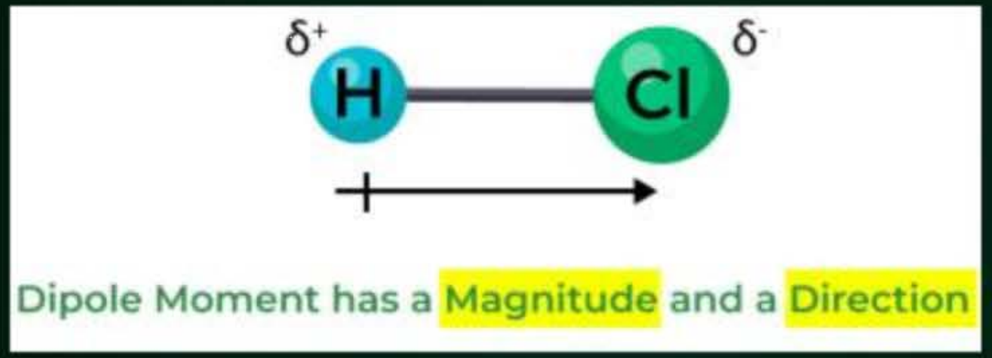
$sp < sp^2 < sp^3$ (B.O / bond length)

Dipole Moment (μ) :

$\mu = 0$ Non polar
$\mu \neq 0$ polar



* Dipole moment is a measure of the net polarity of a molecule.



Dipole Moment has a Magnitude and a Direction

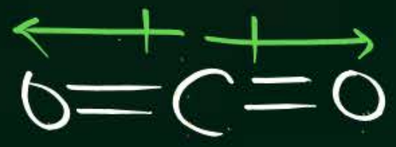
* It is a vector quantity & directed towards more EN element
* Dipole moment of lonepair is always away From the Molecule

Ex

Bond polarity
↓
By ΔEN

Molecule Polarity
by (Net)
Dipole moment

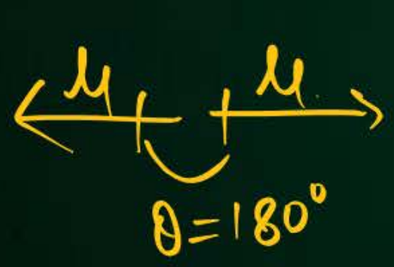
Ex CO_2 AB_2L_0



Polar Bonds present ✓

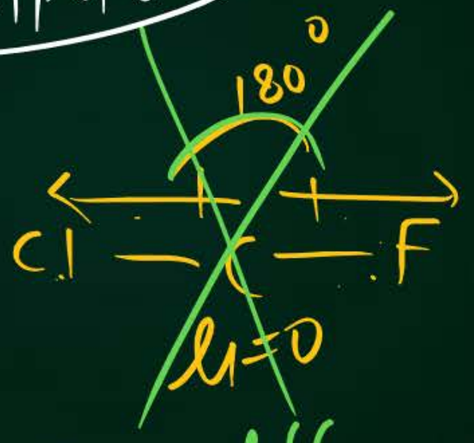
~~Molecule Polar~~

Nonpolar



$\mu_R = 0$

Non polar

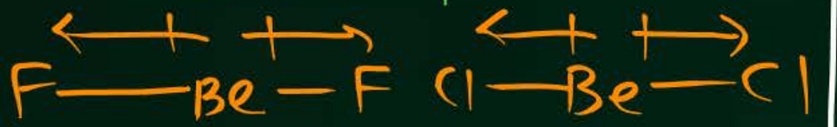


∴ Vectors diff

Ex.2

BeF_2 | $BeCl_2$

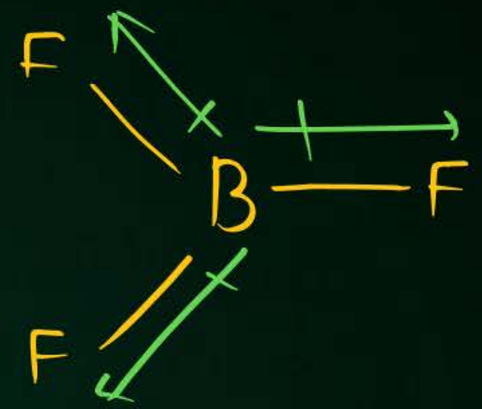
AB_2L_0 | AB_2L_0.

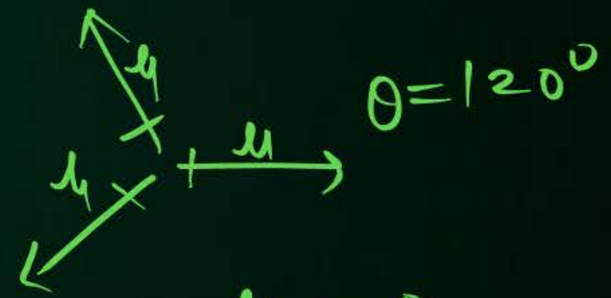


$\mu = 0$ | $\mu = 0$

Non polar.

Ex.3 BF_3 AB_3L_0.





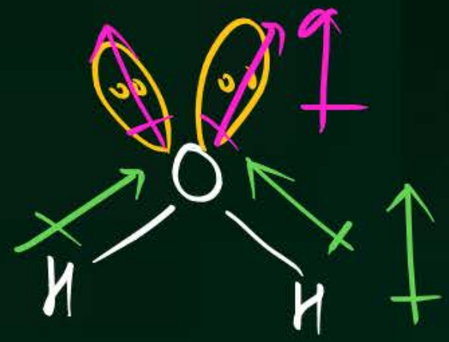
$\mu_R = 0$

Non polar.

Ex. 4

H_2O

AB_2L_2



$\mu \neq 0$

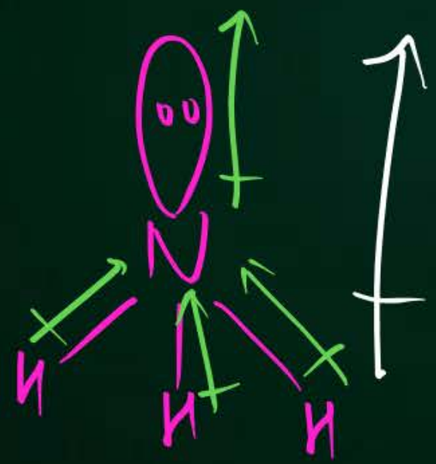
$\mu \neq 0$

Polar ✓

Ex. 5

NH_3

AB_3L_1



$\mu \neq 0$

Polar Molecule

Dipole Moment (μ) :

$\Delta EN \uparrow \quad q \uparrow$

$$\mu = q \times d$$

'q' is magnitude of charge
'd' is internuclear in distance
(Bond length)

1 Debye = 3.3×10^{-30} cb × m

⇒ For symmetrical structures μ is always zero.

NOTE : Vectors must be same.

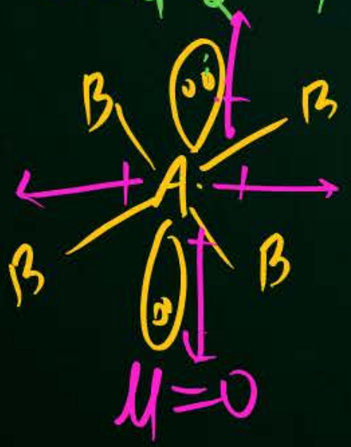
All the Terminal atoms Must be same

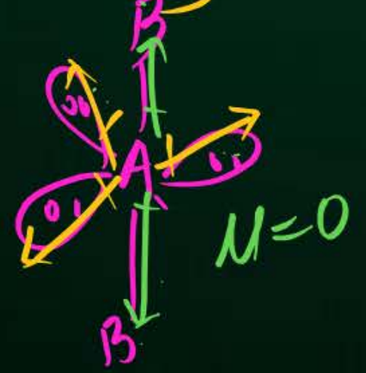
Symmetrical

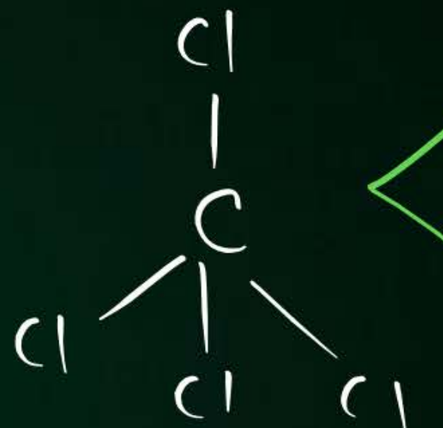
① AB_2L_0 to AB_7L_0

② AB_4L_2 , AB_3L_3

} $\mu = 0$ Non polar





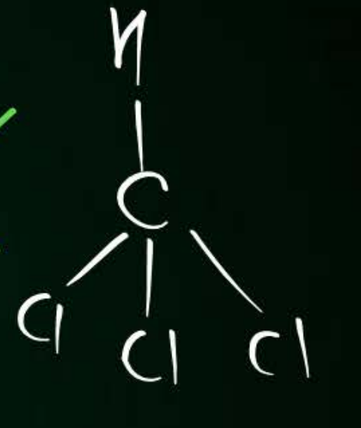


CCl_4

AB_4L_0

$\mu = 0$

Nonpolar solvent.



$CHCl_3$

AB_4L_0

$\mu \neq 0$

∵ Vectors are diff.-

Comparison

(A) (B)

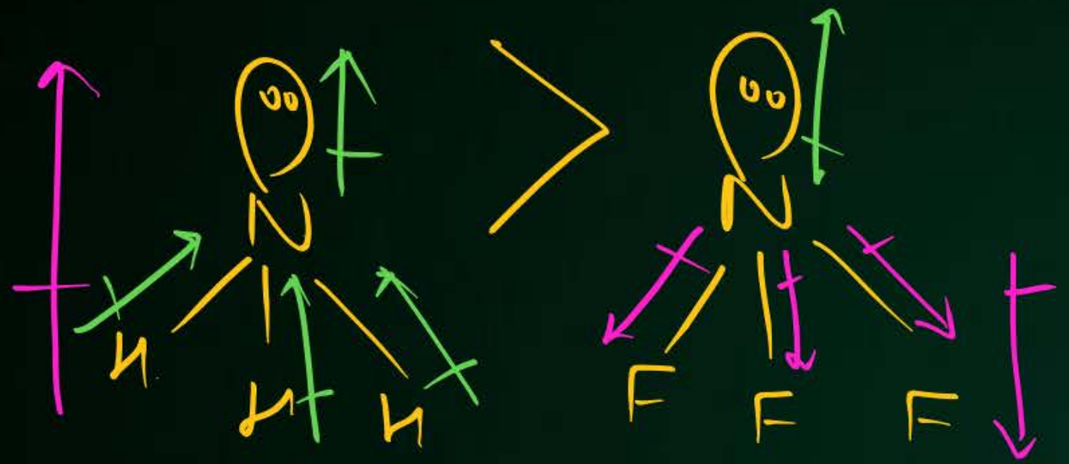
$\mu = 0 = \mu = 0$ ✓

$\mu \neq 0 > \mu = 0$ ✓

$\mu \neq 0 = \mu \neq 0$ ✗

Compare Dipole Moment in following :

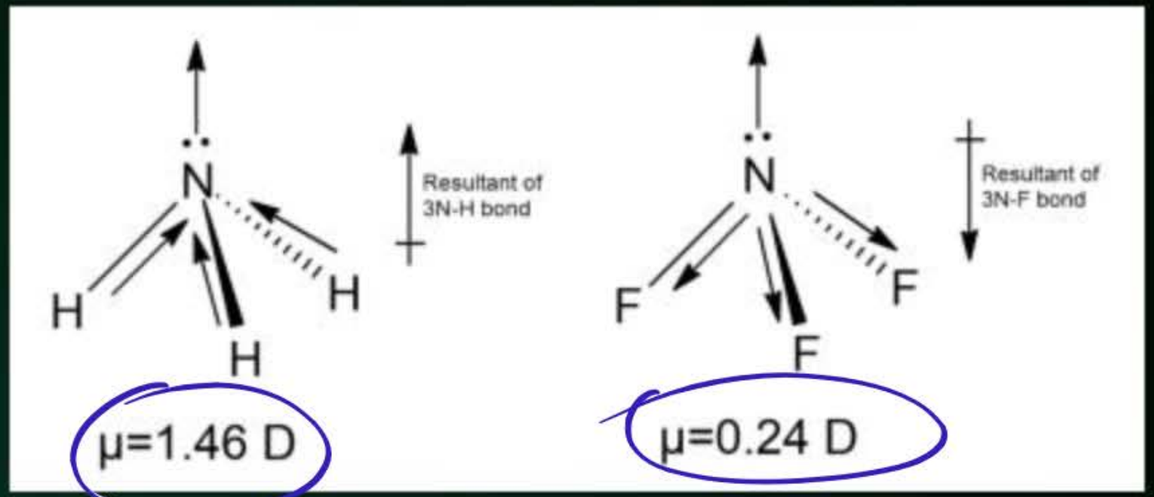
(i) NH_3 > NF_3



$\mu \neq 0$ $\mu \neq 0$

Both Bond dipole and l.p dipole (atomic dipole) are in same direction (μ ↑se)

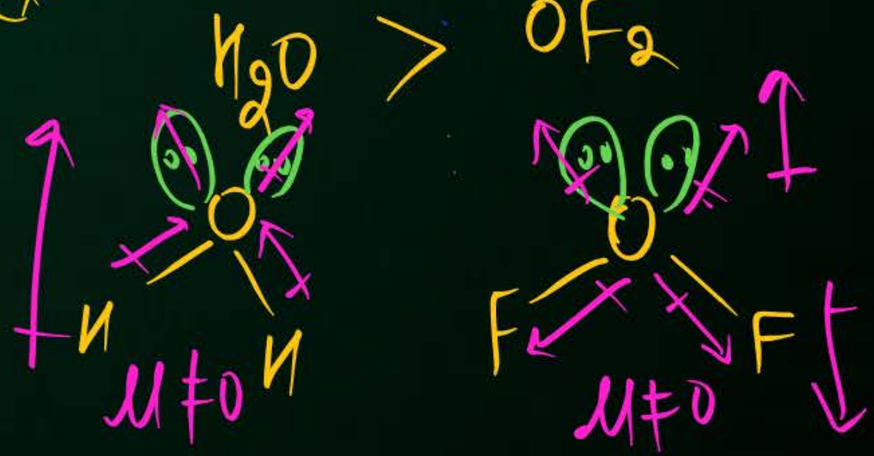
$(NH_3 > NF_3)$



Similar Ex.

Reason

Same as NH_3



(ii) XeO_3 AB_3L_1 $\mu \neq 0$ > XeO_4 AB_4L_0 $\mu = 0$

(iii) $CHCl_3$ AB_4L_0 $\mu \neq 0$ > CCl_4 AB_4L_0 $\mu = 0$

Vec diff

(iv) PCl_3 AB_3L_1 $\mu \neq 0$ > PCl_5 AB_5L_0 $\mu = 0$

(v) SF_4 AB_4L_1 $\mu \neq 0$ > $SiCl_4$ AB_4L_0 $\mu = 0$

(6) SO_2 AB_2L_1 $\mu \neq 0$ > CO_2 AB_2L_0 $\mu = 0$

(7) SO_2 AB_2L_1 $\mu \neq 0$ > SO_3 AB_3L_0 $\mu = 0$

(8) XeF_2 AB_2L_3 $\mu = 0$ = XeF_4 AB_4L_2 $\mu = 0$

(9) SF_4 AB_4L_1 $\mu \neq 0$ > SF_6 AB_6L_0 $\mu = 0$

(10) CO_2 AB_2L_0 $\mu = 0$ < O_3 AB_2L_1 $\mu \neq 0$

(11) $BeCl_2$ < H_2O

(12) $NCl_3 > BCl_3$

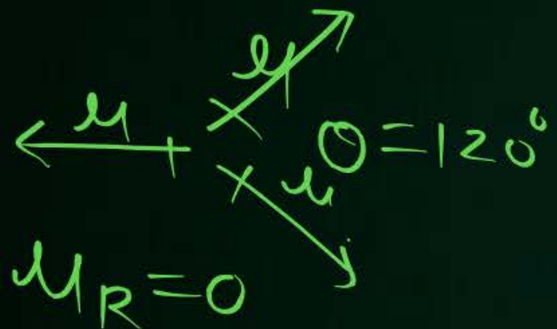
(13) $BF_3 = BCl_3$

(i) $u \leftarrow \quad + \quad \rightarrow u$

$\theta = 180$

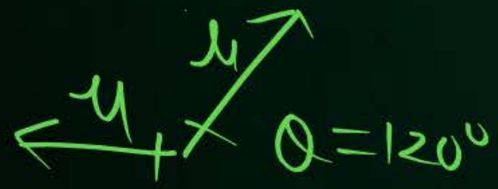
$u_R = 0$

(ii)



$u_R = 0$

(iii)



$u_R = u$

$$u_R = \sqrt{u_1^2 + u_2^2 + 2u_1u_2\cos\theta}$$

$\cos\theta$	0°	60°	120°	180°
	1	$\frac{1}{2}$	$-\frac{1}{2}$	-1

$\theta \uparrow \quad u_R \downarrow$

Ex ①

Benzene

$\mu = 0$

Nonpolar

(2)

$\mu \neq 0$

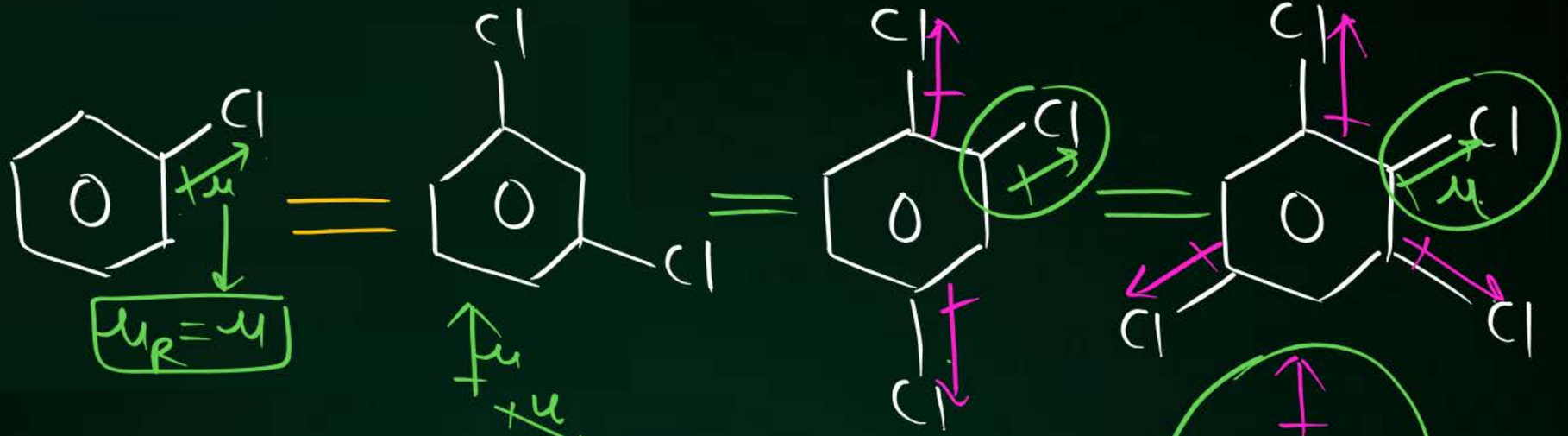
Polar

③

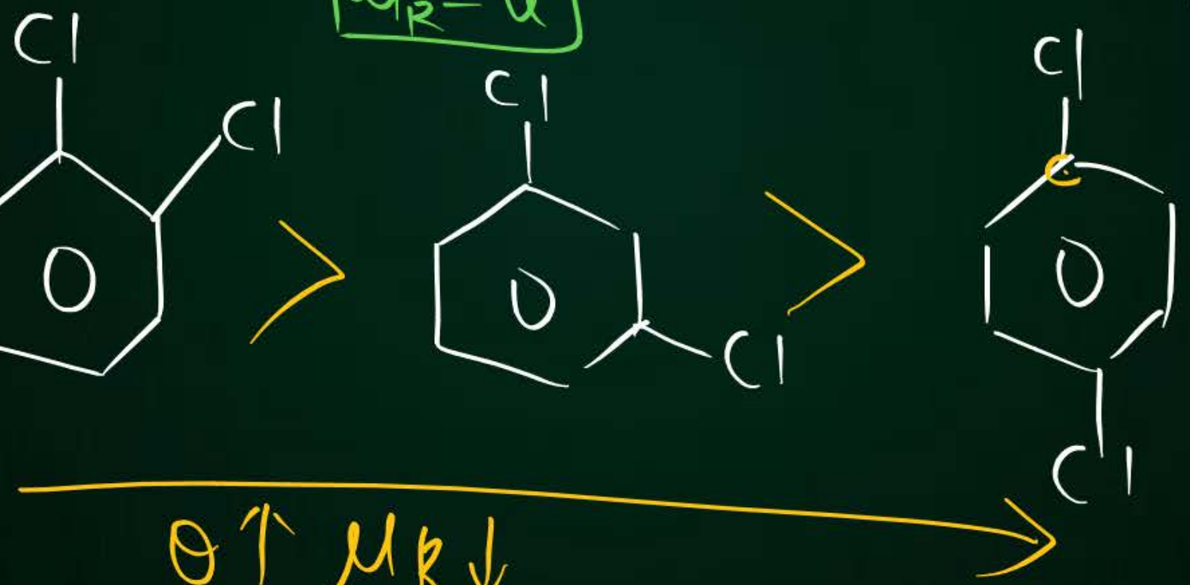
$\mu = 0$

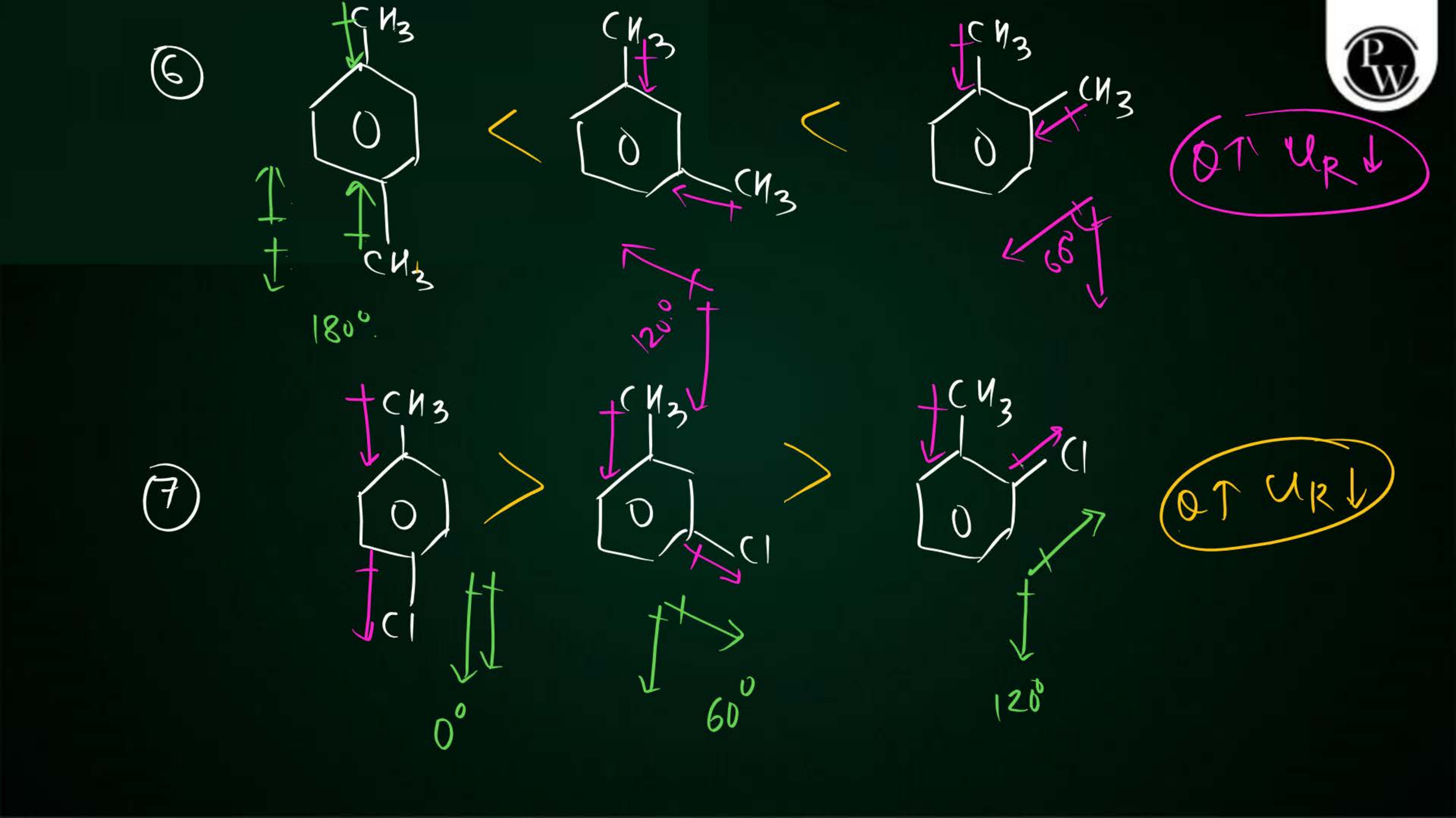
Nonpolar

(4)

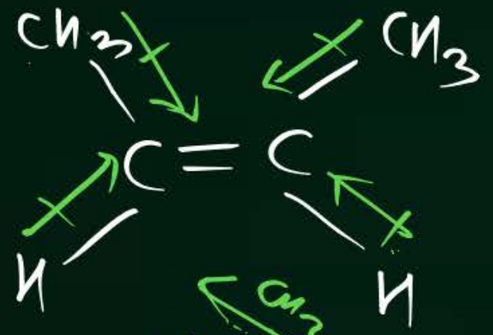


(5)



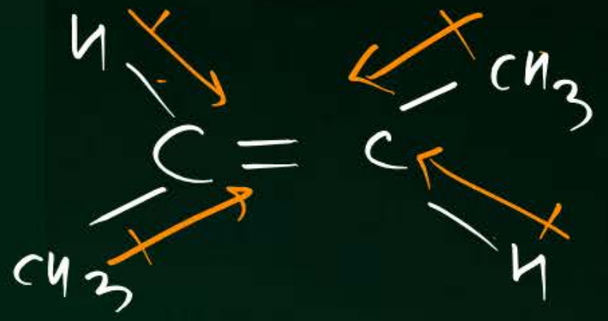

6
CH3
O
CH3
CH3
180°
<
CH3
O
CH3
<
CH3
O
CH3
120°
60°
θ↑ μR↓
7
CH3
O
Cl
0°
>
CH3
O
Cl
60°
>
CH3
O
Cl
120°
θ↑ μR↓

(8)



Cis Butene

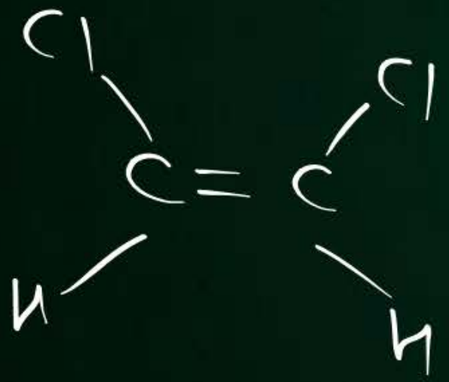
$\mu \neq 0$

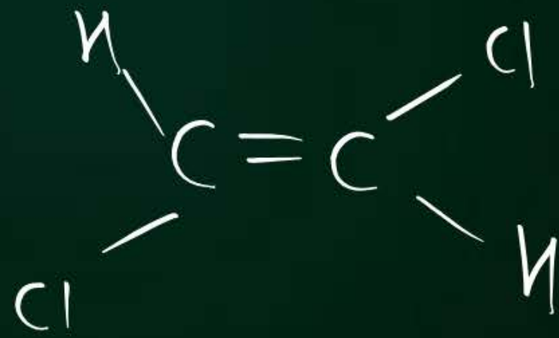


Trans - Butene

$\mu = 0$

(9)





H.W

Examples based on q

Imp

$\Delta EN \uparrow \; q \uparrow \; \mu \uparrow$

$\mu = q \times d$

(i) HF > HCl > HBr > HI

(ii) HF > NH_3 > PH_3

H – F N – H P – H

(iii) H_2O > NH_3 > PH_3

O → H N – H P – H

(iv) H_2O > H_2S

Some special example (Data based) :

(i) CH_3F (2) CH_3Cl (1) CH_3Br (3) CH_3I (4)

1 > 2 > 3 > 4

(ii) CH_3Cl (1) CH_2Cl_2 (2) $CHCl_3$ (3) CCl_4 (4)

(iii) H_2O > HF (Acc. to NCERT)

Cl > F > Br > I

E.A

Homework

Module - 1

questions Based on

dipole moment

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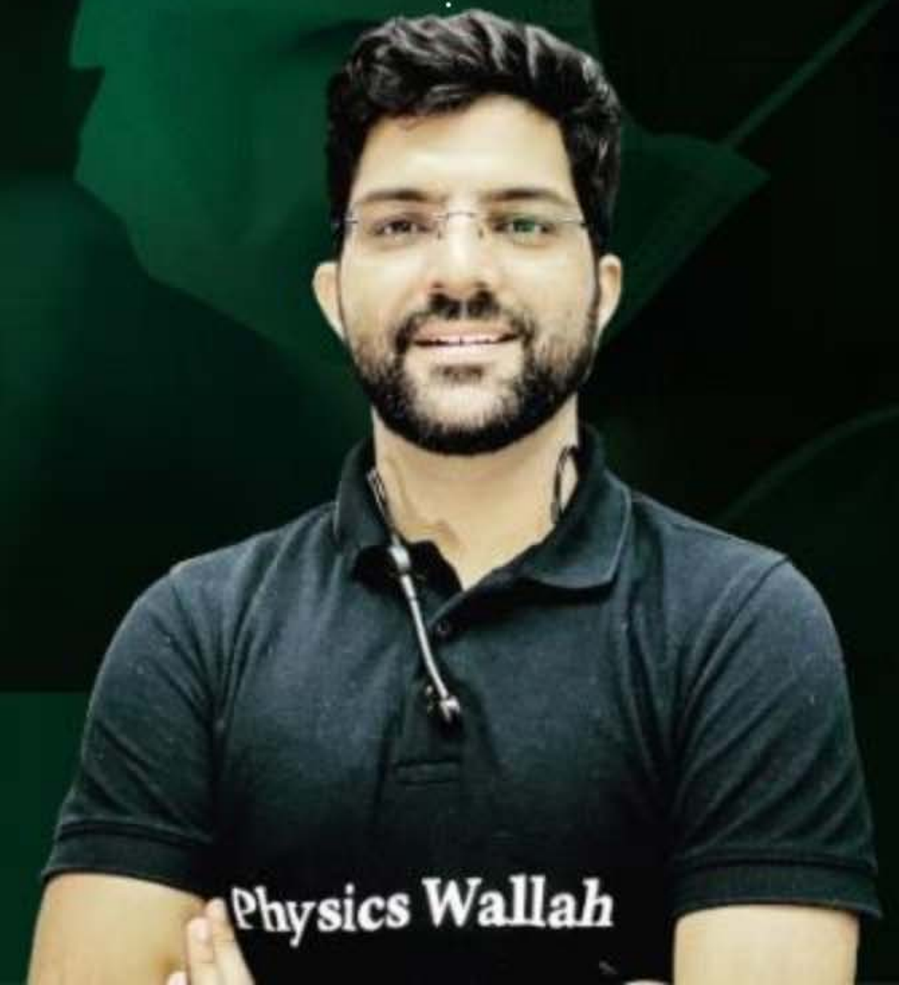
FOR NEET 2025

Lecture - 11 | Inorganic Chemistry

Chemical Bonding & Molecular Structure



By - Mohit Dadheech (MD Sir)

Topics *to be covered*

1. Ionic Bond/Electrovalent Bond

Lec.7 (H.W) Ans Bond strength order:

$C-C > Si-Si > Ge-Ge > Sn-Sn$

$C-C < C=C < C\equiv C$

$N-N < N=N < N\equiv N$

$C=N < C\equiv N$

$C=O < C\equiv O$

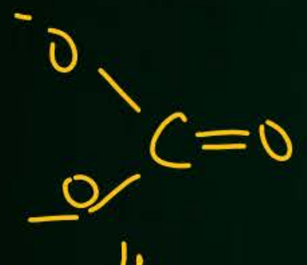
$O-O < O=O$

$H-F > HCl > HBr > HI$

$CO_3^{2-} > CO_2 > CO$ (C–O Bond length)

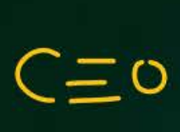
B.O $\propto \frac{1}{\text{B.L}}$

$O_2 < O_3 < H_2O_2$ (O–O Bond length)



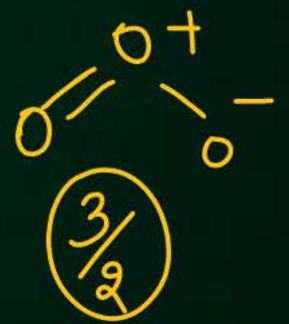
B.O $\frac{4}{3}$ (1.33)

2

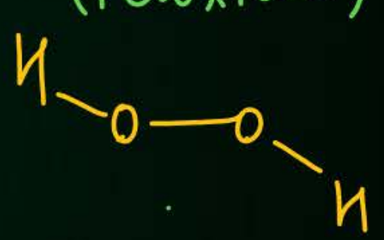


3

2



$\frac{3}{2}$ = 1.5



1

Q $XeO_3F_2 \Rightarrow$ Bond pairs ($\sigma+\pi$), bondpairs (π), l.p at Xe respectively.

(1) 5, 2, 0

(2) 4, 2, 2

(3) 8, 3, 0 ✓

(4) 4, 4, 0

AB_5L_0

$\frac{8+18+14}{8} \quad \frac{40}{8} = 5$ Q

R = 0

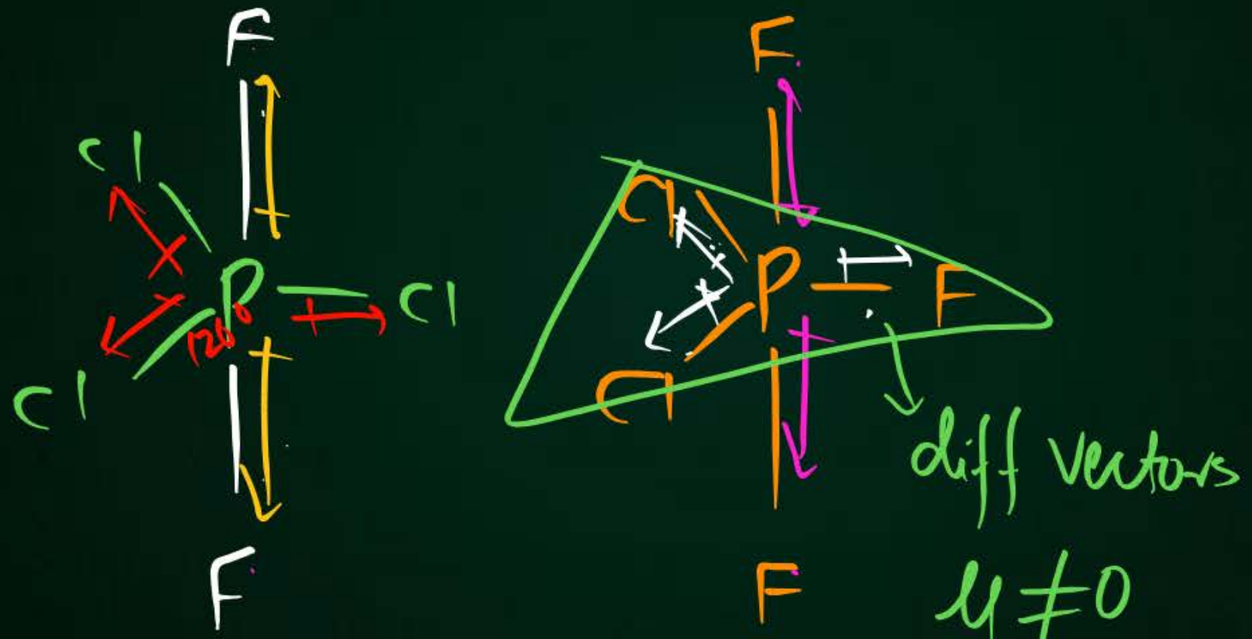
AB_mL_n

B_m: σ Bond Pair

L_n: no. of l.p at c.A

Dipole Moment Special Examples

Ex.1 PCl_3F_2 < PCl_2F_3



$\mu = 0$

Nonpolar

diff vectors

$\mu \neq 0$

Polar

Ex-2

$\mu = 0$

N·P

$\mu = 0$

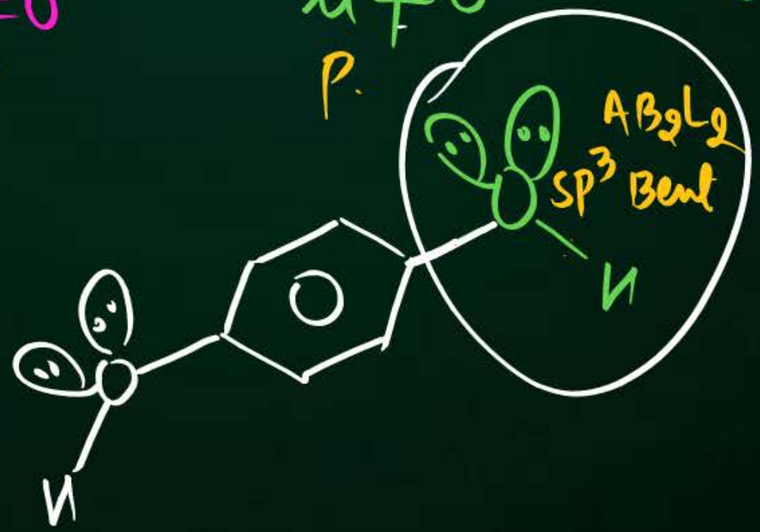
N·P

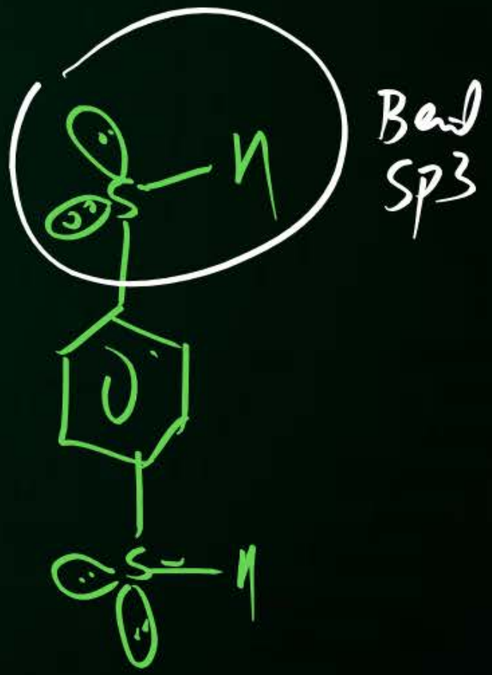
$\mu \neq 0$

P.

$\mu \neq 0$

P.





Ionic Bond / Electrovalent Bond :

Valency → Na^+ Cl^-

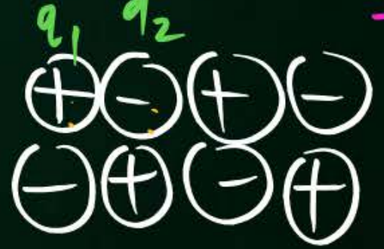
- Bond formed by complete transfer of electron.
- Electrostatics force / coulombic force of attraction b/w oppositely charged ions.

$$F = \frac{K q_1 q_2}{r^2}$$

- Generally formed b/w metals and non-metals.

Metals → Electropositive → Cation → Having Low I.E

Non-metals → Electronegative → Anion → High ΔHeg

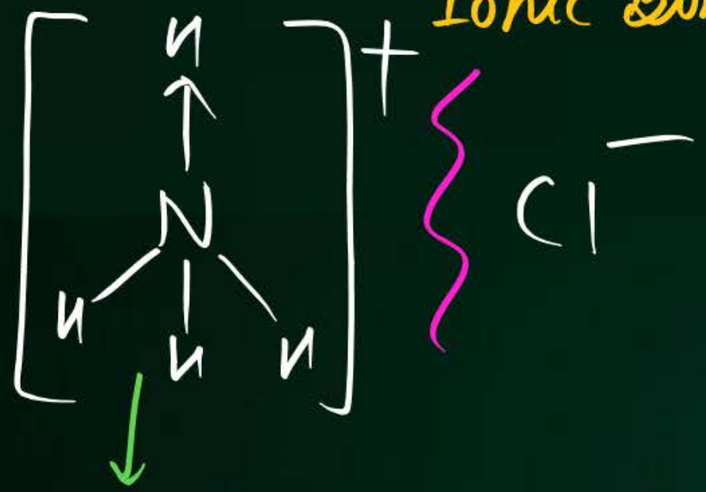


3D Crystal Lattice.

Ex NH_4Cl

Metal ~~Present~~

Ionic Bond ✓✓



- Simple covalent
- Coordinate

NH_4Cl

- Coordinate ✓
- Simple covalent ✓
- Ionic ✓

Ex. $CsBr_3$

Ionic Bond.

$Cs^{+} \} Br_3^{-}$

Br^{-}

O.S of Cs ~~+3~~

Never

Alkali metal always show +1 O.S

Ex.

$Tl^{+1} \} I_3^{-}$

$TlI_3 \rightarrow$ ~~Tl^{+3}~~

~~I^{-}~~

- Ionic compounds are generally solid, brittle in nature at room temperature.

∵ due to strong electrostatic Force of attraction.

- Ionic compound do not show isomerism.

Reason :- due to absence of directional Bonds.

- Ionic compound are polar and readily soluble in polar solvent like water.

isomerism (Molecular Formula same)

↓

directional property

required directional Bonds

Cov. Compounds

Ionic Bond → Non directional

Covalent → Directional Bond.

$+\delta \quad -\delta$

$A - B$ Polar Bond

Covalent Bond → ΔEN present → Ionic ch↑ ✓

Polarity ↑

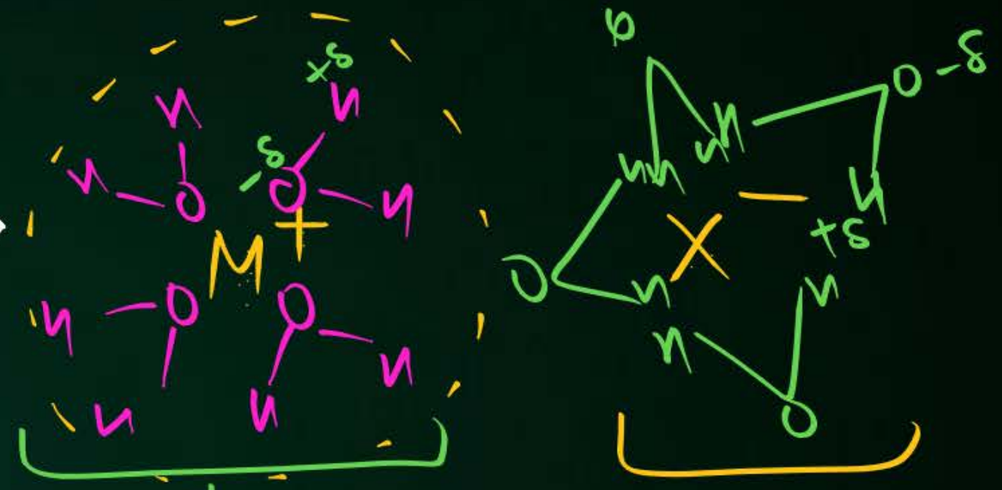
$A^{+\delta} B^{-}$

Ionic → Polar →

Polar compounds dissolve in polar solvent like water

Ionic Compound + Water → Hydration

$M^+X^- + nH_2O \longrightarrow$



Hydrated Cation

Hydrated anion.

Hydration

Bonding

B/w ions & water Molecule

∴ Exothermic Process

Energy Release. (Hydration Energy)

degree of Hydration ↑se ⟶ Hydration Energy ↑se
(More Exothermic)

Some imp orders

$Li^+ < Na^+ < K^+ < Rb^+ < Cs^+$ (Size (Normal))

$Li^+ > Na^+ > K^+ > Rb^+ > Cs^+$ (degree of Hydration)

$Li^+ > Na^+ > K^+ > Rb^+ > Cs^+$ (Size of Hydrated ion)

$Li^+ < Na^+ < K^+ < Rb^+ < Cs^+$ (Ionic Mobility or Conductance)

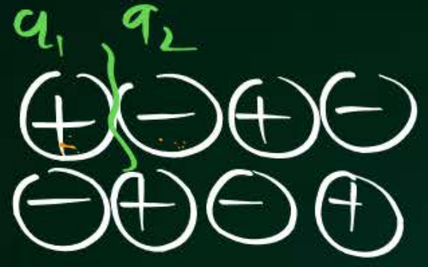
(ϕ ⇒ Polarising Power of Cation)

$$\phi \propto \frac{\text{charge}}{\text{radius}}$$

$$\phi \propto \frac{q^+}{r^+}$$

- Ionic compounds have high M.P & B.P. as Compare to Covalent Compounds

Ionic Compounds



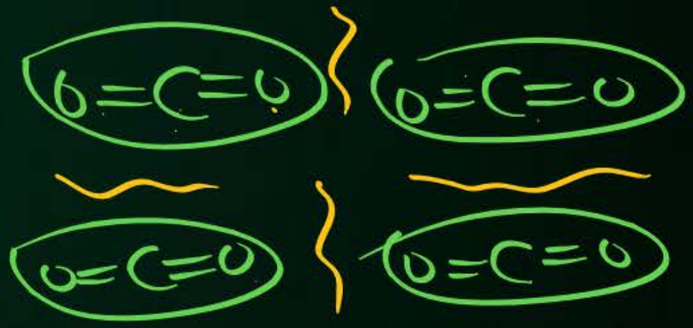
$$F = \frac{K q_1 q_2}{r^2}$$

Strong electrostatic Force of attraction b/w q_1 & q_2

∴ High M.P & B.P

(Existin Molecules) (Molecular Solid)

$CO_2(s)$



Weak Vanderwaal Force b/w CO_2 Molecules

Electrical conductivity :

Ionic Compounds	Solid	aq.	liquid (Molten)
Presence of ions	✓	✓ In Form of Hydrated ion	✓
Mobility of Ions	✗	✓	✓
Conductance	✗	✓	✓

Electrical conductivity :

Covalent Compounds

	Solid.	aq.	liquid (Molten)
Presence of ions.	✗	✓	✗
Mobility of Ions	✗	✓	✗
Conductance	✗	✓	✗

* Metals can Conduct electricity in all state due to presence of Free e^-

Q Which of the Following Pair can Conduct electricity

(1) $KCl_{(s)}$, $HCl_{(\ell)}$

(2) $Fe_{(s)}$ $KCl_{(s)}$

(3) $Fe_{(s)}$ $HCl_{(s)}$

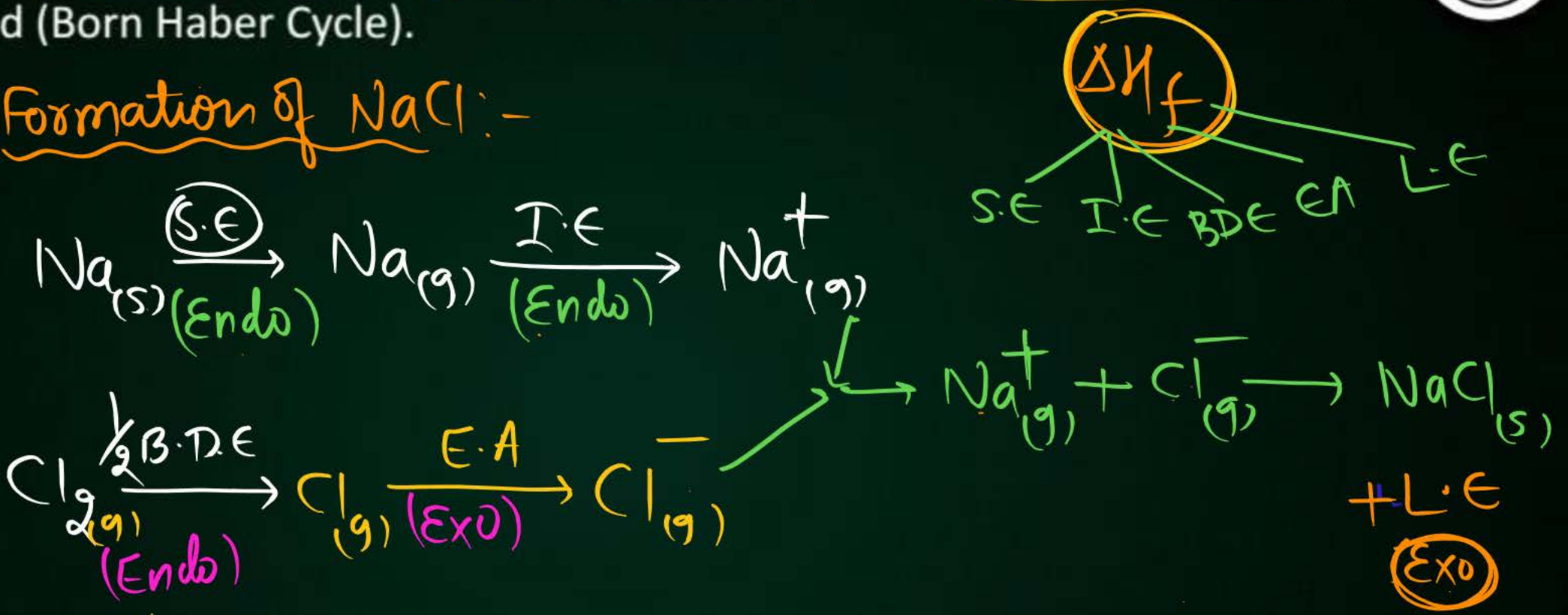
(4) $KCl_{(\ell)}$ $HCl_{(aq)}$

HCl → covalent

KCl ionic

- To form a stable ionic compound released energy must be greater than energy absorbed (Born Haber Cycle).

Ex Formation of NaCl :-



MDJ

For stable ionic Compound

Exo > Endo

Released Energy > Absorbed Energy.

E.A , L.E > S.E , B.D.E , I.E

of Non Metal

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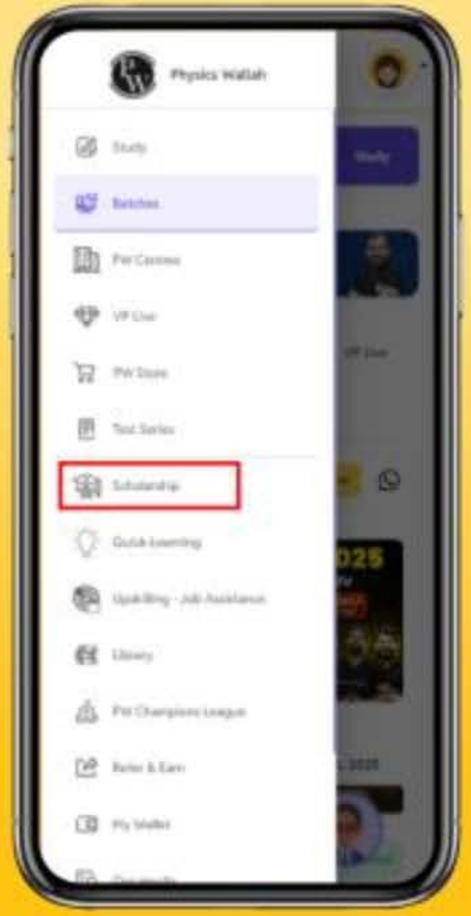

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Date
1 October 2024
Time
Duration
12:00 AM TO 11:59 PM 60 minutes
The exam will be proctored.
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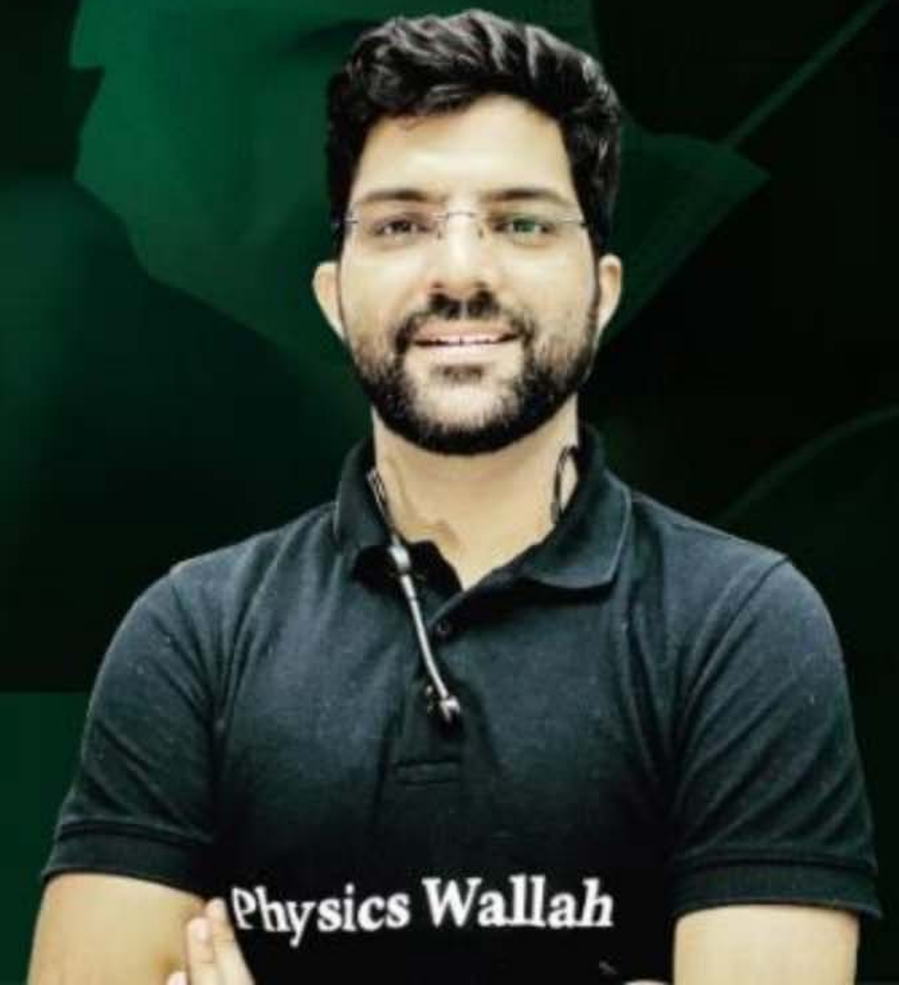
Lecture - 12 | Inorganic Chemistry

Chemical Bonding & Molecular Structure

By - Mohit Dadheech (MD Sir)



Topics *to be covered*

1. Lattice Energy
2. Fajan's Rule

Lattice Energy (U) :

Lattice Energy (U) :

Amount of energy released when 1 mole of ionic solid is formed by its constituents gaseous ions.

MDJ

$U \propto |q_1||q_2|$

If charge Same then

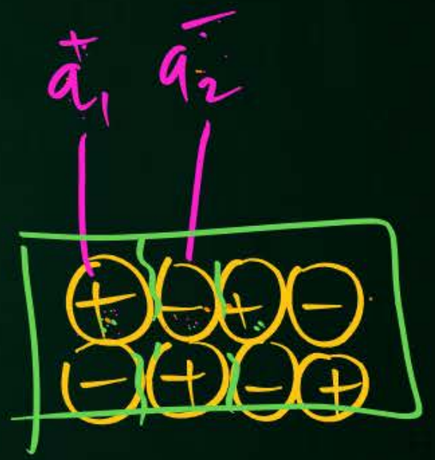
$U \propto \frac{1}{\gamma}$

$M^+_{(g)} + X^-_{(g)} \longrightarrow MX_{(s)} + \text{L.E. (U)}$

$U = -\frac{Aq_1q_2}{r} + \frac{B}{r^n}$

Attraction

Repulsion Negligible



γ

QUESTION

Give correct order of L.E. in following

$NaF > NaCl$

$NaCl < Na_2O$

$KCl > RbCl$

$KCl < K_2O$

$MgO > Na_2O$

$MgO < Al_2O_3$

$Li_3N > Na_3N$ * non existing due to very low L.E

$Na_2O > Na_2S$

N^{3-} Nitride

Alkaline earth metals Nitride Exist

Group-I Alkali metals Only Li_3N Exist.

QUESTION

The stability of ionic crystal principally depends on :

1. High electron affinity of anion forming species
2. The lattice energy of crystal
3. Low I.E. of cation forming species
4. Low heat of sublimation of cation forming solid

QUESTION

Solid NaCl is a bad conductor of electricity because :

1. In solid NaCl, there are no ions
2. Solid NaCl is covalent
3. In solid NaCl, there is no mobility of ions
4. In solid NaCl, there are no electrons

QUESTION

The order of increasing lattice energy of the following salt is :

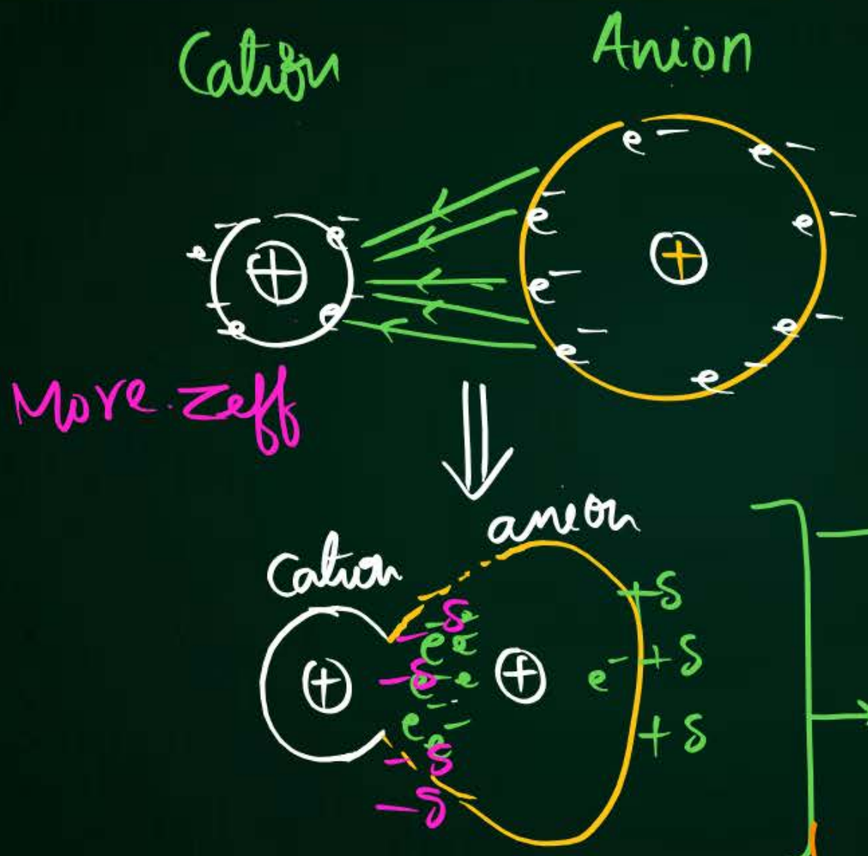
1. NaCl < CaO < NaBr < BaO
2. NaCl < NaBr < CaO < BaO
3. NaBr < NaCl < BaO < CaO
4. NaCl < CaO < BaO < NaBr

Development of covalent character in ionic compounds (Fajan's Rule) :

Cation

$p^+ > e^-$

Z_{eff} ↑se



- Polarisation in anion's e^- cloud (distortion)
- Merging of e^- clouds of cation & anion → overlapping
- Covalent character ↑se

when polarisation ↑se ⟶ Covalent ch. ↑se.

① when polarising Power (ϕ) of cation Increase

$$\phi \propto \frac{q^+}{r^+}$$

→ Small cation

→ High charge on Cation

② when polarisability of Anion ↑se.

Polarisability $\propto q^- \propto r^-$

→ Large anion

→ High charge on anion.

$\overset{+\delta}{A}-\overset{-\delta}{B}$

Covalent

Diff ↑se

% Ionic ch.

Bond polarity ↑

$A^{+}\sim B^{-}$

Ionic

Polar

Cov ↑

c

depolarization of Compound

Conditions for maximum covalent character :

- Small cation
- Large anion
- High charge on cation
- High charge on anion

(1) $F^- < Cl^- < Br^- < I^-$ (Polarisability)

(2) $Be^{2+} > Mg^{2+} > Ca^{2+} > Sr^{2+} > Ba^{2+}$ (Polarising Power)

ϕ

$\phi \propto \frac{q.t}{r.t}$

In a group

Top to Bottom

$r.t \uparrow \phi \downarrow$

③ $M^{+} < M^{2+} < M^{3+}$

④ $Cr^{2+} < Cr^{3+} < Cr^{+6}$

⑤ $Mn^{2+} < Mn^{+4} < Mn^{+7}$

⑥ $Fe^{2+} < Fe^{3+}$

⑦ $Sn^{2+} < Sn^{+4}$

} Polarising power

⑧ $O^{-} < O^{2-}$

⑨ $X^{-} < X^{2-} < X^{3-}$

} Polarisability

Important Points

(i) Na^+, K^+, Rb^+, Cs^+ = Low ϕ

(ii) d block cations have more polarising power (ϕ) than s block cation.

Size ↓

ϕ ↑

(iii) LiCl, $BeCl_2$, $MgCl_2$ soluble in organic solvents like benzene, pyridine and acetone.

↳ small cation, very high ϕ, max. covalent ch → soluble in non polar solvent.

(iv) Due to covalent character M.P. of ionic compounds decreases.

$\therefore$ $\overset{+2}{Sn}Cl_2 < \overset{+4}{Sn}Cl_4$ (cov. ch.)

$\therefore$ $SnCl_2 > SnCl_4$ (M.P)

QUESTION

Give correct order of covalent character in following :

$NaF < NaCl < NaBr < NaI$ ($F^- < Cl^- < Br^- < I^-$ Polarisability ↑, Polarisation ↑

$LiF < LiCl < LiBr < LiI$

$SnCl_2 < SnCl_4$ $q^+ \uparrow, \phi \uparrow$, Cov. ch ↑

$NaCl < CuCl$

$CaCl_2 < CdCl_2$

$FeCl_2 < FeCl_3$

QUESTION

Al^{3+} $3F^-$ Ionic.

Give correct order of covalent character in following :

$AlF_3 < AlCl_3 < AlBr_3 < AlI_3$

$NaCl < ZnCl_2 < SiCl_4 < AgF < AgCl < AgBr < AgI$

$HgF_2 < HgCl_2 < HgBr_2 < HgI_2$

$PbF_2 < PbCl_2 < PbBr_2 < PbI_2$

$SiCl_4$ → Completely Covalent

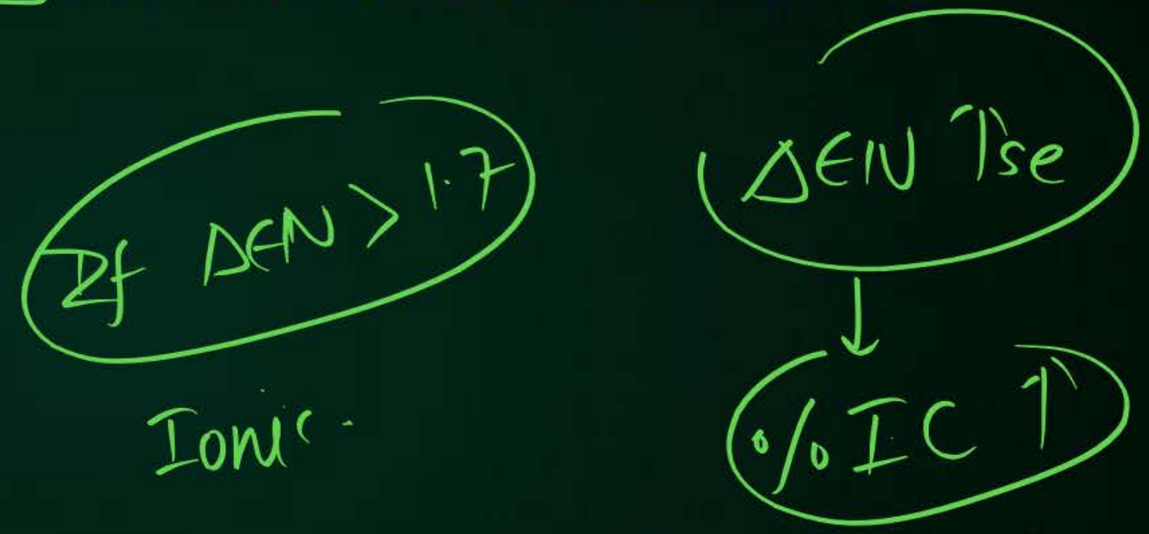
$SiCl_4$
AB_4L_0, sp^3
Tetrahedral

$LiI > NaBr > KCl > RbF$

QUESTION

Element X is strongly electropositive and element Y is strongly electronegative. Both are univalent. The compound formed would be

1. X^+, Y^-
2. X^-, Y^+
3. X - Y
4. $X \rightarrow Y$



QUESTION

Statement-I : LiCl is predominantly a covalent compound.

Statement-II : The electronegativity difference between Li and Cl is too small.

LiCl

Covalent

(Reason) → due to High degree of Polarisation in Anion's e^- cloud.

(Li^+) ($\gamma+ \downarrow \phi \uparrow$)

St. I → True

St. II → False

QUESTION

In an ionic compound A^+X^- the degree of covalent bonding is greatest when:

1. A^+ and X^- ion are small
2. A^+ is small and X^- is large
3. A^+ and X^- ions are approximately of the same size
4. X^- is small and A^+ is large

Homework

From Module – 1

Question Based on Ionic Bond

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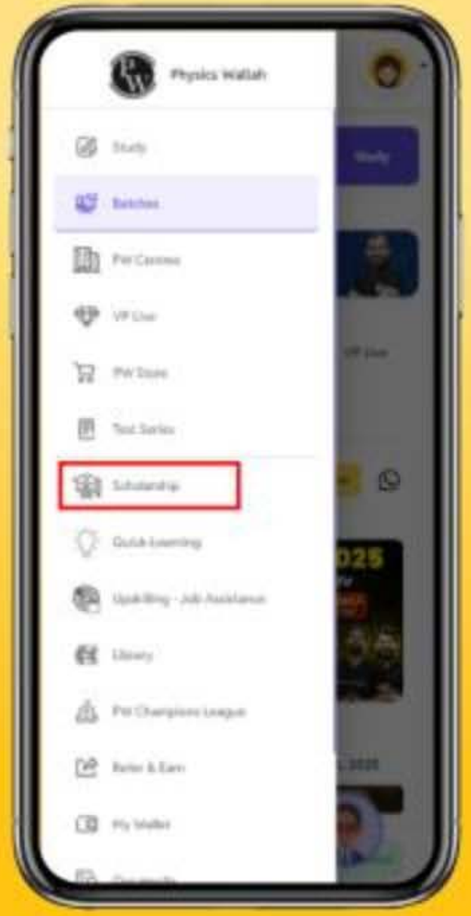

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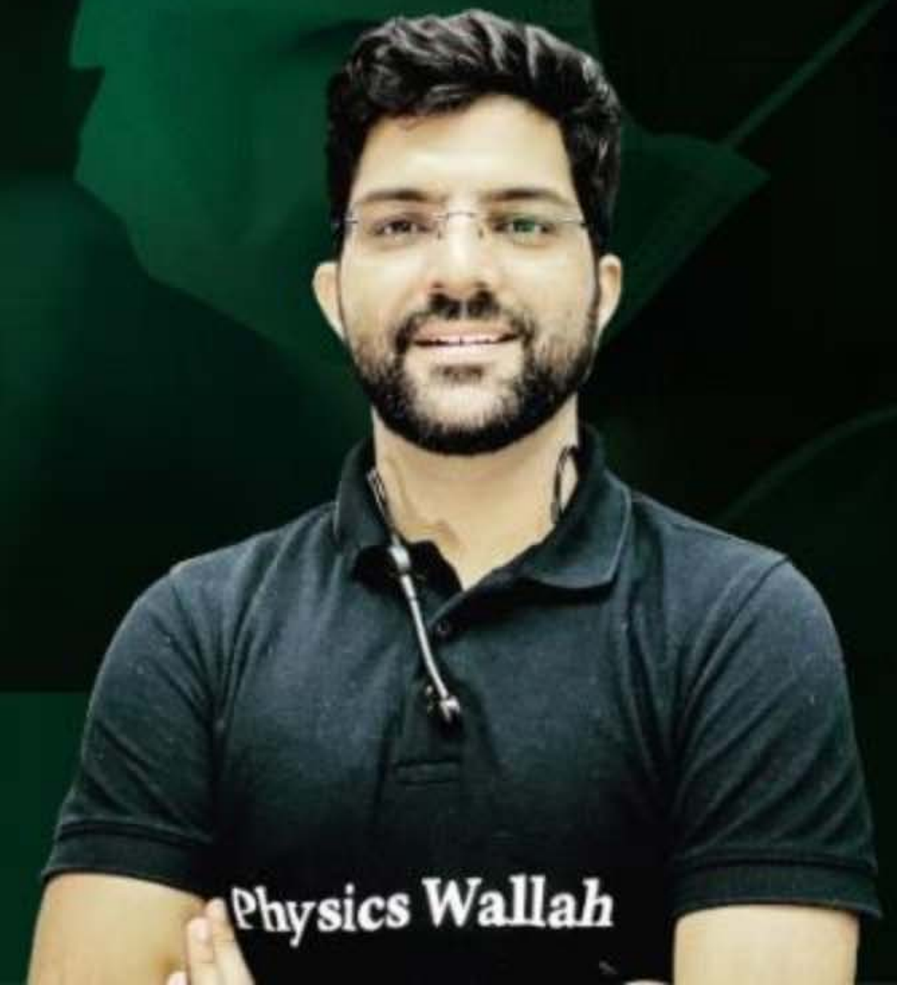
Lecture - 13 | Inorganic Chemistry

Chemical Bonding & Molecular Structure

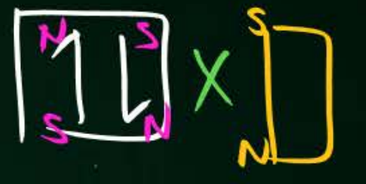
By - Mohit Dadheech (MD Sir)



Topics *to be covered*

1. Molecular Orbital Theory

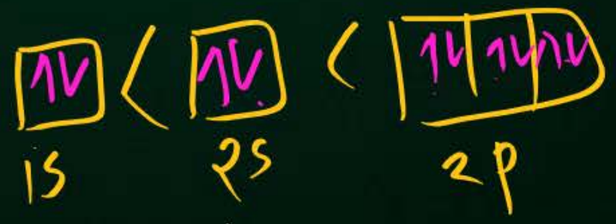
Molecular Orbital Theory



- Paramagnetic behavior of O_2 is explained by MOT.
- As per our syllabus we will study this theory only for homodiatomic molecules (total electrons upto 20).

N_2 B_2 C_2 H_2, Li_2, O_2, F_2, Ne_2
14e⁻ 10e⁻ 12e⁻ 2e⁻ 6e⁻ 16e⁻ 18e⁻ (20e⁻)

- Acc. to MOT when two atomic orbitals of almost similar energy and same symmetry interact with each other two new molecular orbitals formed of diff. energy.
- The molecular orbitals like atomic orbitals are filled in accordance with the aufbau principle obeying the Pauli's exclusion principle and the Hund's rule.

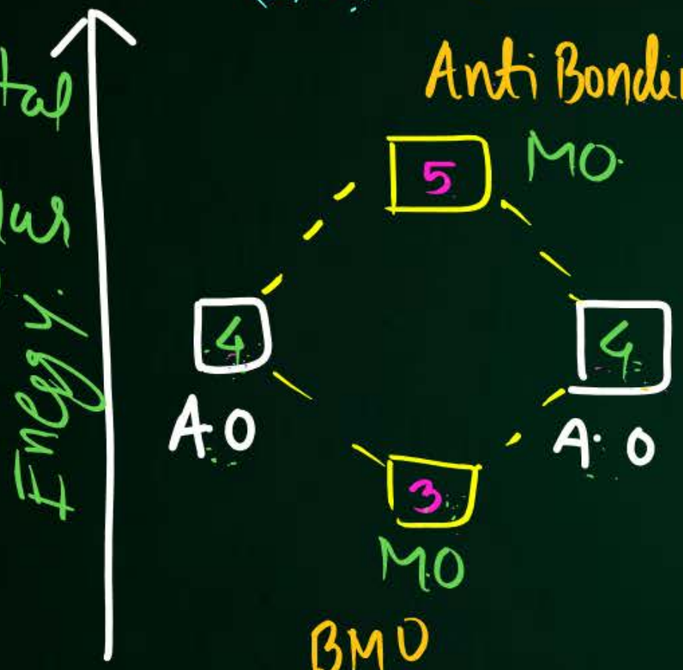


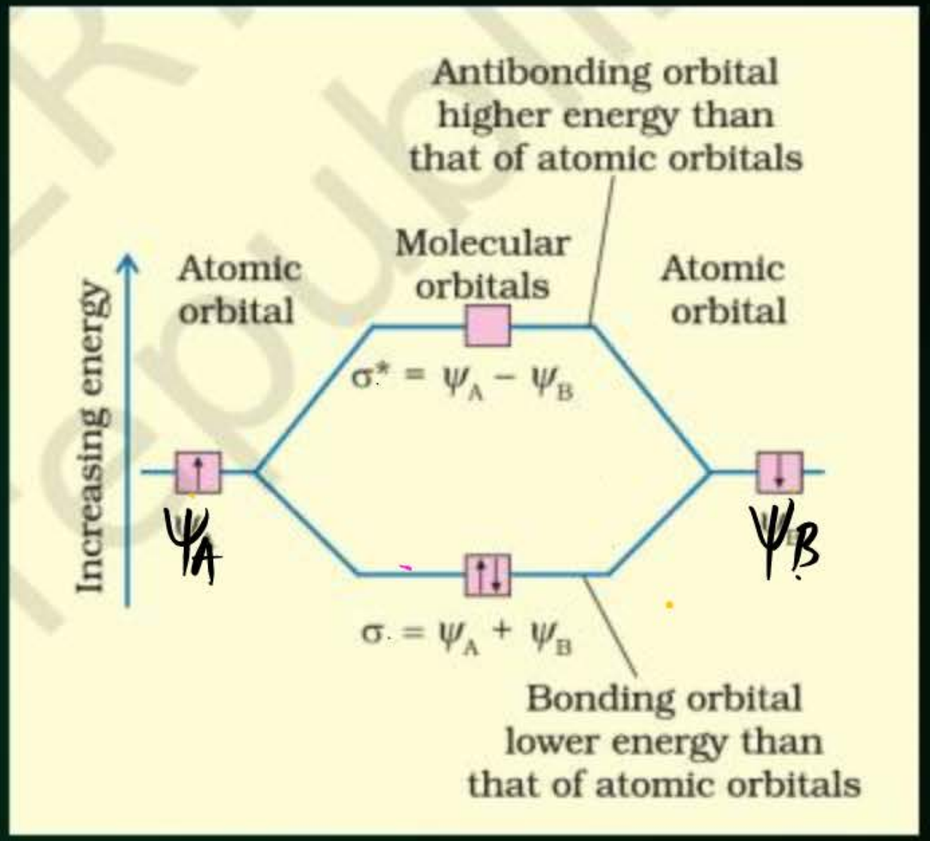
Molecular Orbital Theory

Jitne Milenge – Utne Banenge
(A.O) (M.O)

AO → Atomic orbital

MO → Molecular Orbital





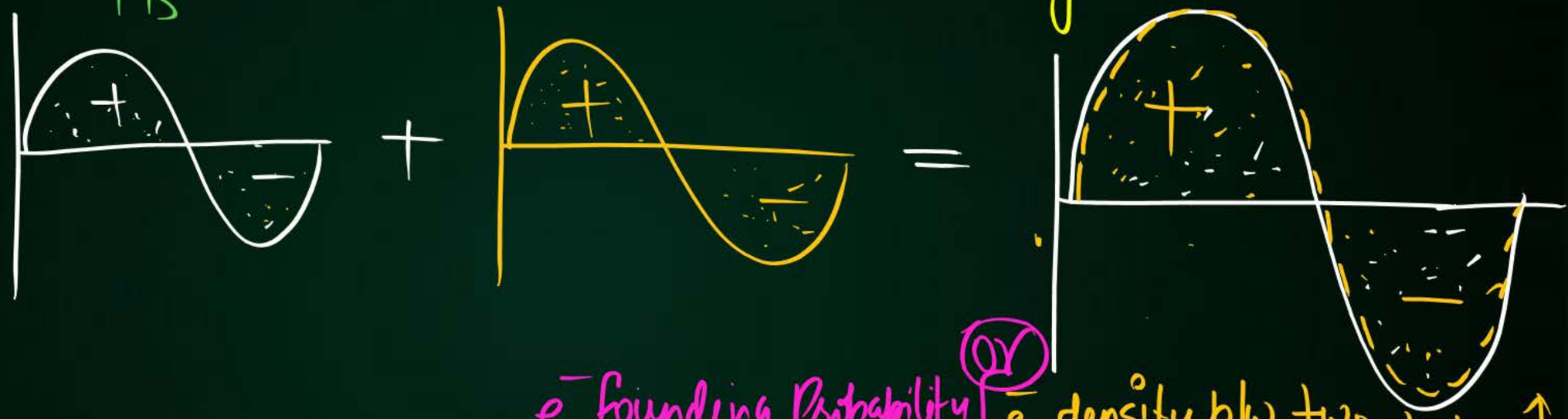
$\psi_{(AB)} = \psi_A \pm \psi_B$

Constructive Interference :

$$\psi_{BMO} = \psi_A + \psi_B$$

Formation of (BMO)

Bonding Molecular Orbital



e^- founding Probability ↑ (ψ) e^- density b/w two Nucleus ↑se

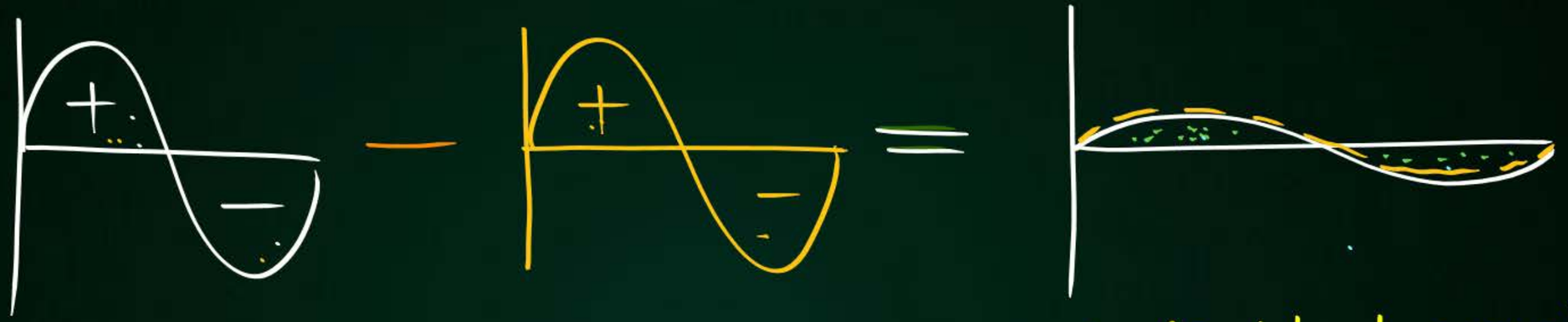
b/w Nucleus ↑se

Bond Banega → Attraction ↑se

Energy ↓se

Destructive Interference :

Formation of ABMO.



→ $\bar{e}$ density b/w two nucleus ↓se.

→ Repulsion ↑e

→ Energy High.

Electronic Configuration : $\Rightarrow$ (e^- Filling into Molecular orbitals)

(O_2, F_2, Ne_2)

Beyond N_2 $\Rightarrow$ Normal, without s-p mixing, MDJ $\Rightarrow$ 1221

Up to N_2 $\Rightarrow$ Exceptional, with s-p mixing, MDJ $\Rightarrow$ 2121

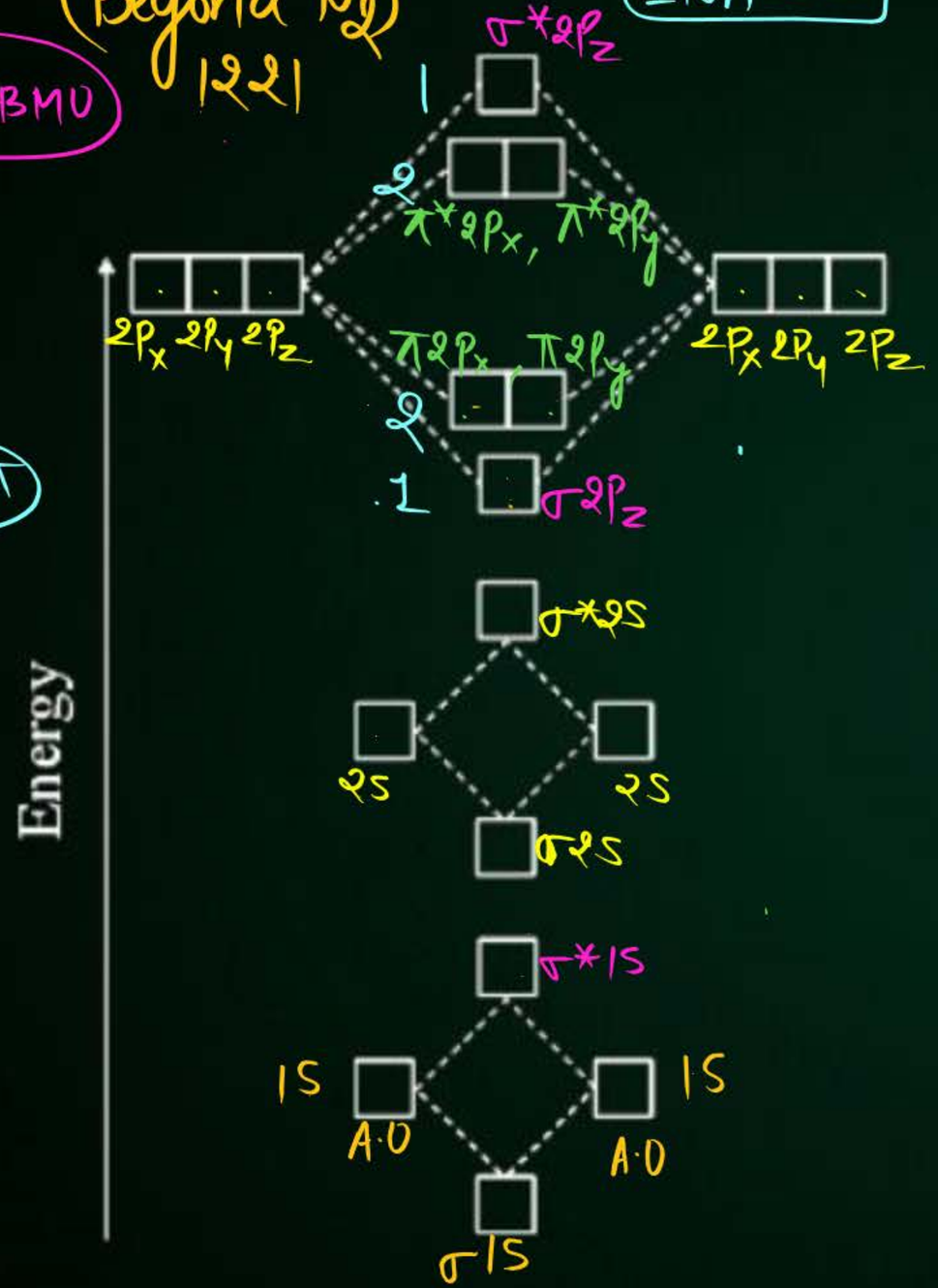
(H_2 to N_2)

(Beyond N_2)
1221

INA = Z

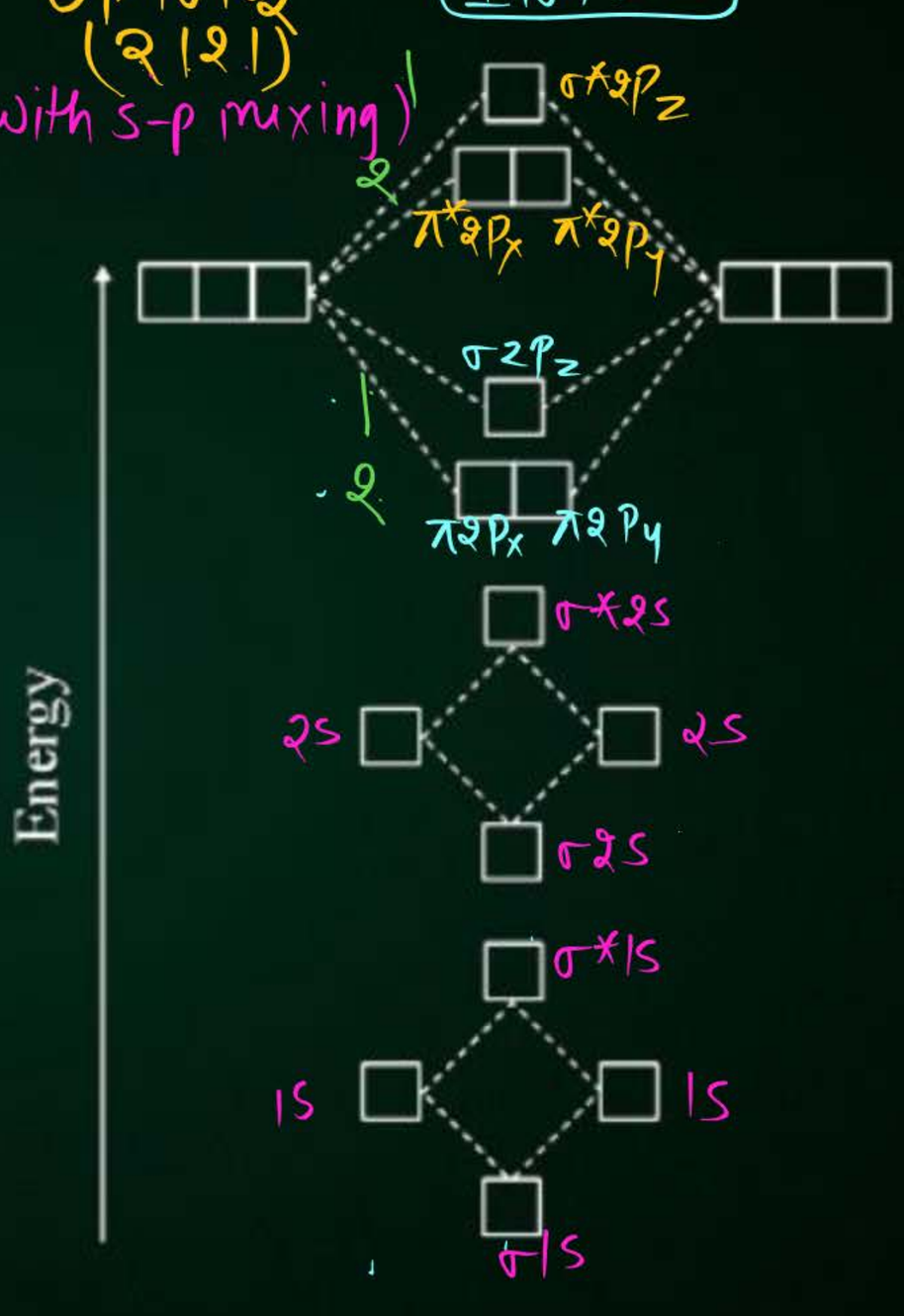
(* → ABMU)

(σ > π)



Up to N_2
(2121)
(with s-p mixing)

INA = Z



Beyond N_2 (1221)

$\sigma 1s < \sigma^* 1s < \sigma 2s < \sigma^* 2s < \sigma 2p_z <$ ($\pi 2p_x$ = $\pi 2p_y$) $<$ ($\pi^* 2p_x$ = $\pi^* 2p_y$) $< \sigma^* 2p_z$

Up to N_2

$\sigma 1s < \sigma^* 1s < \sigma 2s < \sigma^* 2s <$ ($\pi 2p_x$ = $\pi 2p_y$) $< \sigma 2p_z <$ ($\pi^* 2p_x$ = $\pi^* 2p_y$) $< \sigma^* 2p_z$

2121

Upto N_2

$N_2 \Rightarrow 14e^-$ (7+7)

$\sigma 1s < \sigma^* 1s < \sigma 2s < \sigma^* 2s <$ $\pi 2p_x = \pi 2p_y$ $< \sigma 2p_z$

OMO

HOMO for N_2

$< \pi^* 2p_x = \pi^* 2p_y < \sigma^* 2p_z$

LUMO for N_2

UMO

LOMO

HUMO

Highest OMO

HOMO

OMO → occupied MO

UMO → Unoccupied MO

LUMO → Lowest UMO

For O_2 (1221)

$8+8=16e^-$

$\sigma 1s < \sigma^* 1s < \sigma 2s < \sigma^* 2s < \sigma 2p_z < \pi 2p_x = \pi 2p_y < \pi^* 2p_x = \pi^* 2p_y < \sigma^* 2p_z$

$\pi 2p_x$: ↑↓ ; $\pi 2p_y$: ↑↓ ; $\pi^* 2p_x$: ↑ ; $\pi^* 2p_y$: ↑

2 Unpaired e^- are present in $\pi^*/\pi ABMO$ thats why O_2 is Paramagnetic

≠ MDJ

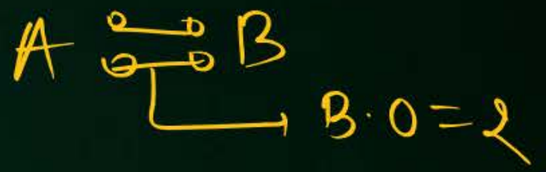
If

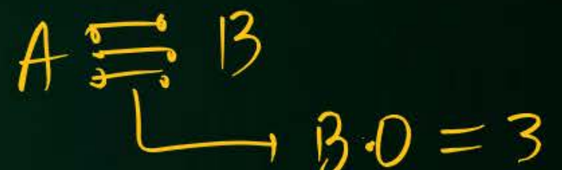
1 e^- ↑se in BMO → B.O ↑se by 0.5

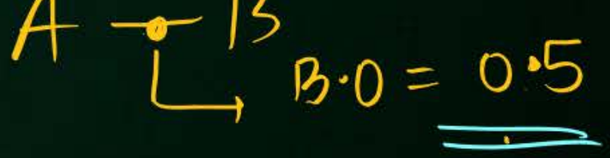
1 e^- ↓se From BMO → B.O ↓se by 0.5

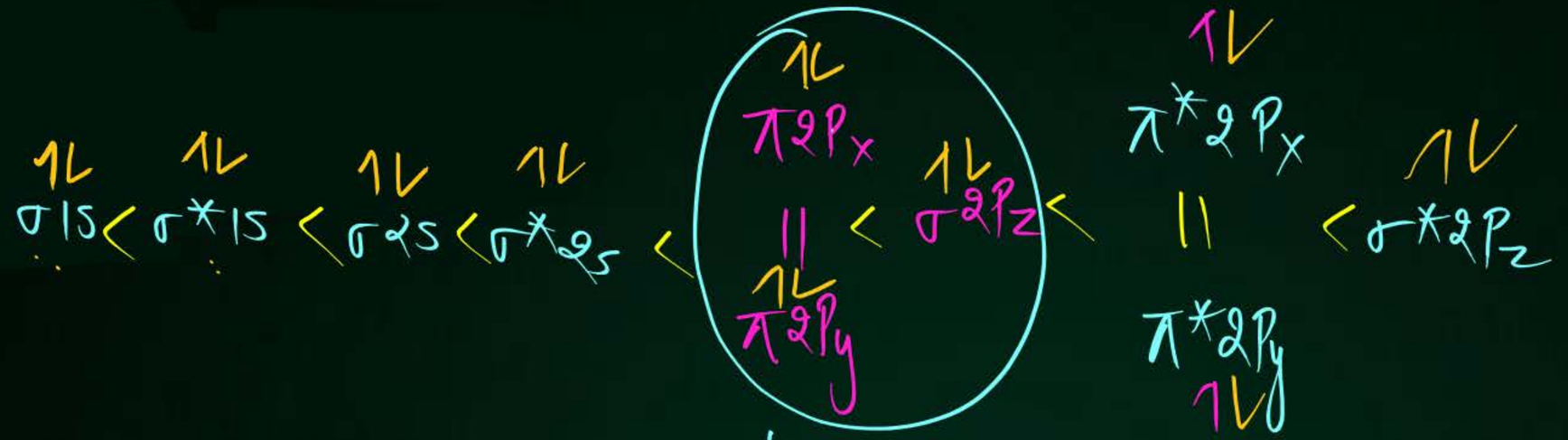
1 e^- ↑se in ABMO → B.O ↓se by 0.5

1 e^- ↓se From ABMO → B.O ↑se by 0.5









Total e^-	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
B.O	0	0.5	1	0.5	0	0.5	1	0.5	0	0.5	1	1.5	2.0	2.5	3.0	2.5	2.0	1.5	1.0	0.5	0

e^- Use From BMO → B.O Use

e^- Use in ABMO → B.O Use

Bond order Formula

$$B.O = \frac{\text{Total BMO } e^- - \text{Total ABMO } e^-}{2}$$

QUESTION

Which of the following M.O. are degenerated (INA is z)

1. $\sigma 1s, \sigma^* 1s$

2. $\pi 2p_x, \pi^* 2p_x$

3. $\pi 2p_x, \pi 2p_y$

4. $\sigma 2p_z, \pi 2p_x$

Magnetic Nature

Total e^-

odd no.

Paramagnetic.

even no.

Diamagnetic

Except B_2, O_2, S_2

130S

Para

Homework

Find B.O & Magnetic Nature (Para / Dia) in Following species.

1. N_2
2. N_2^+
3. O_2^+
4. O_2
5. B_2
6. C_2
7. F_2
8. O_2^{2+}
9. O_2^{2-}
10. O_2^-
11. C_2^-
12. Li_2
13. Be_2^+
14. He_2
15. Ne_2
16. Be_2
17. H_2^{2-}
18. H_2

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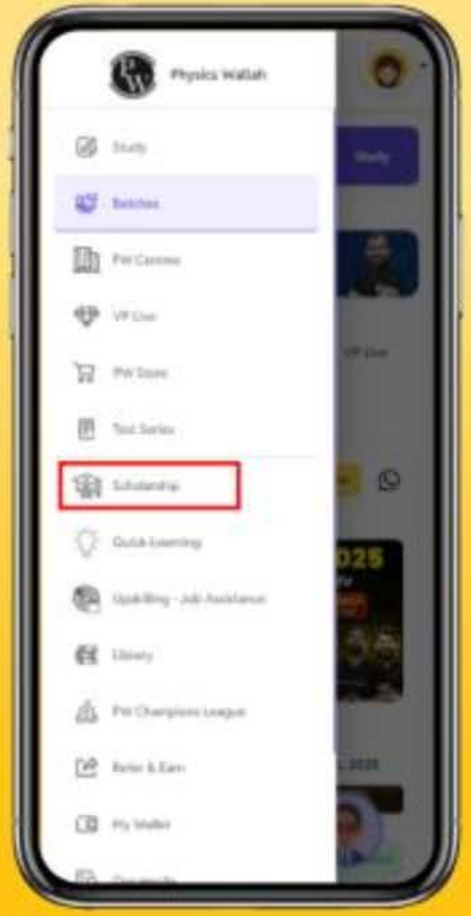

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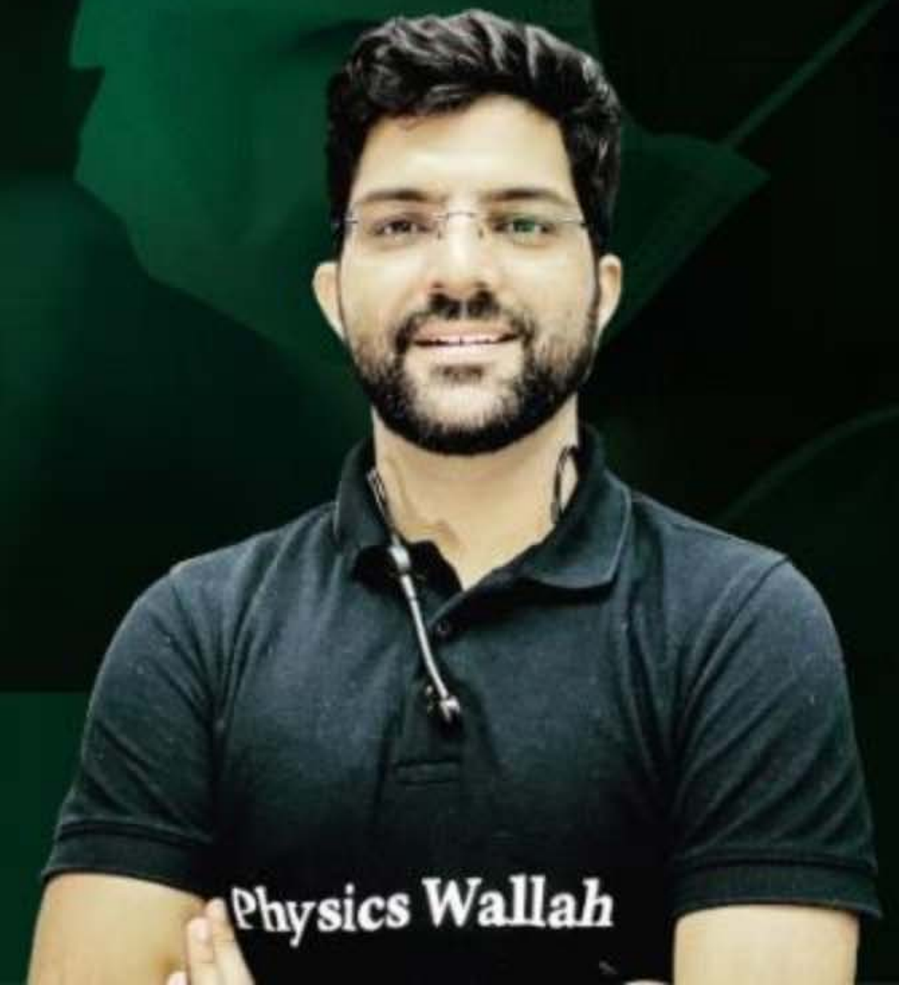
FOR NEET 2025

Lecture - 14 | Inorganic Chemistry

Chemical Bonding & Molecular Structure

By - Mohit Dadheech (MD Sir)



Topics *to be covered*

1. Molecular Orbital Theory (Remaining Part)
2. H-Bonding

Homework

Find B.O & Magnetic Nature (Para / Dia) in Following species.

1. N_2 14, dia
2. N_2^+ 2.5, P
3. O_2^+ 2.5, P
*4. O_2 2, ~~P~~
*5. B_2 1, P ~~D~~
6. C_2 2, D
7. F_2 1, D
8. O_2^{2+} 3, D
9. O_2^{2-} 1, D
10. O_2^- 1.5, P
11. C_2^- 2.5, P
12. Li_2 1, D
13. Be_2^+ 0.5, P
14. He_2
15. Ne_2
16. Be_2
17. H_2^{2-}

doesnot Exist Because B.O = 0

18. H_2 1, D

SOME IMP. POINTS

NOTE

Generally B.O ↑se (no. of Bonds ↑se)

Bond strength ↑se

Bond length ↓se

B.O ∝ stability

* If B.O. of two species are same then stability $\propto \frac{1}{\text{ABMO } e^-}$

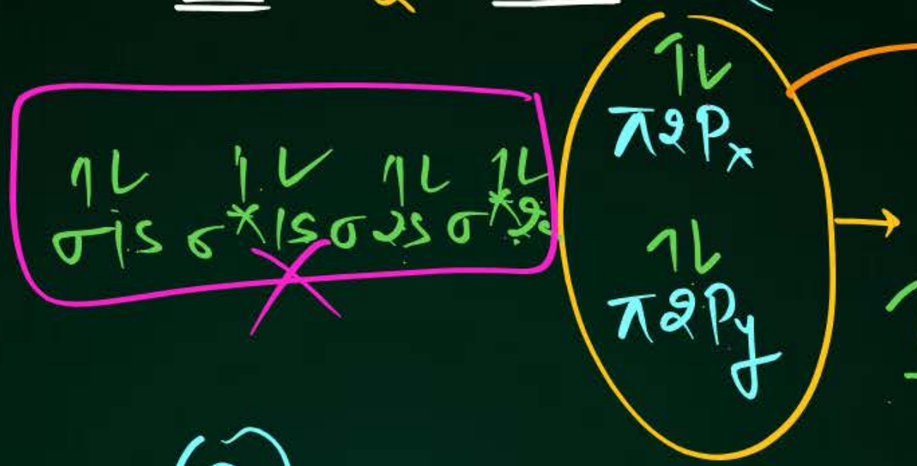
Ex ≡	Li_2	Li_2^+	Li_2^-
B.O	(1)	0.5	0.5
ABMO e^-	2	2	3

$Li_2 > Li_2^+ > Li_2^-$ (stability)

Bond order

- σ Bond order
- π Bond order.

Ex C_2 $12e^-$ (2121)



4 π BMO e^-
∴ 2 π Bonds.
Bond order = 2

Type of Bond. ⇒ (π)

C_2 → gas

exist at high temp

$\frac{8-4}{2} = 2$

$\frac{4-0}{2} = 2$

Ex B_2 $10e^-$ (2121)

Bond order → 1

Type → π

Only 1 π is present

2121

Upto N_2

$N_2 \Rightarrow 14e^-$ (7+7)

↑↓ ↑↓ ↑↓ ↑↓

$\sigma 1s < \sigma^* 1s < \sigma 2s < \sigma^* 2s <$

↑↓ $\pi 2p_x$ ↑↓ $< \sigma 2p_z <$

$\pi 2p_y$ ↑↓

$\pi^* 2p_x$ || $< \sigma^* 2p_z$

$\pi^* 2p_y$

$$\frac{10-4}{2} = \frac{6}{2} = 3$$

Total 6 BMO $e^- \Rightarrow$ B.O = (3)

4 π BMO e^- 2 σ BMO e^-

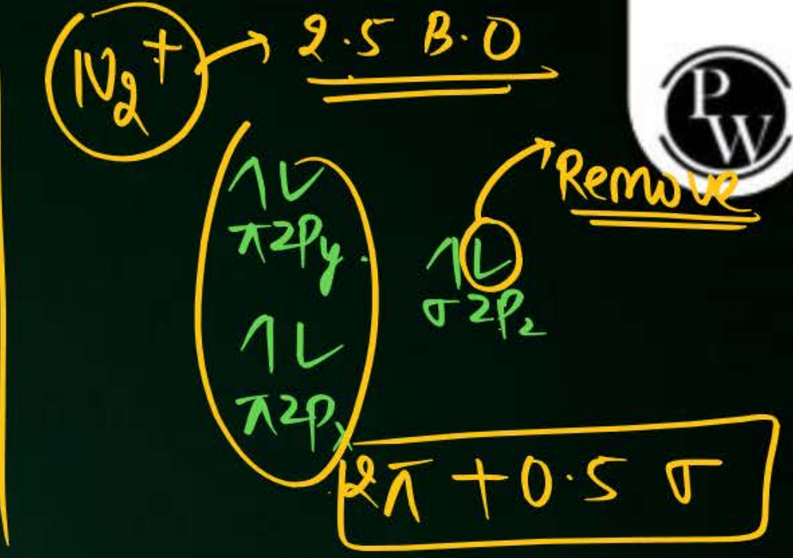
$2\pi + 1\sigma \Rightarrow$ (3)

$N_2 \longrightarrow N_2^-$

$1e^-$ addition into π ABMO.

B.O ↓se by 0.5

B.O = 2.5



Q. Correct B.O of N_2^- → $15e^- \Rightarrow$ B.O = 2.5

(1) $1.5\sigma + 1\pi$

(2) $2\pi + 0.5\sigma$

(3) $1.5\pi + 1\sigma$

(4) All of these

For O_2 (1221)

$8+8=16e^-$

$\sigma 1s < \sigma^* 1s < \sigma 2s < \sigma^* 2s < \sigma 2p_z < \pi 2p_x = \pi 2p_y < \pi^* 2p_x = \pi^* 2p_y < \sigma^* 2p_z$

$1\sigma + (2\pi - 1\pi) \Rightarrow 1\sigma + 1\pi$

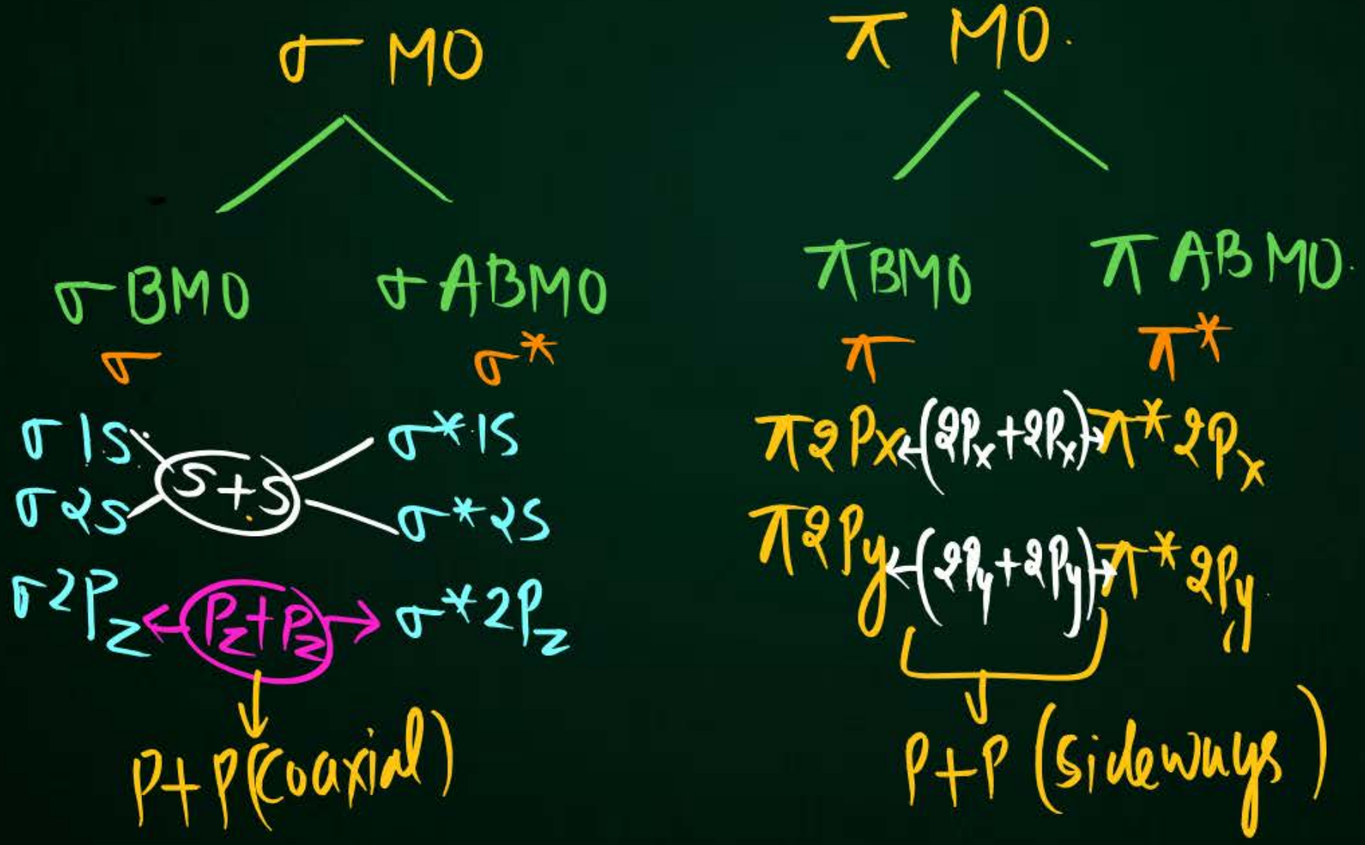
O_2^+	2.5	$(1\sigma + 1.5\pi)$
O_2^-	1.5	$(1\sigma + 0.5\pi)$
O_2^{2-}	1.0	$(1\sigma + 0\pi)$
O_2^{2+}	3.0	$(1\sigma + 2\pi)$

B.O = 2

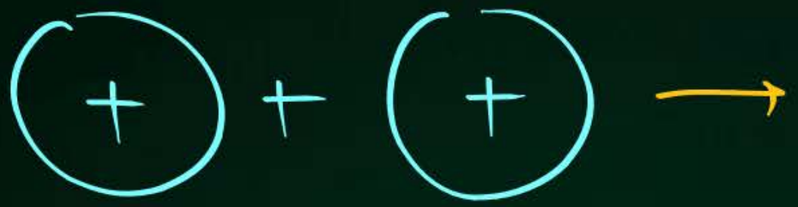
LCAO → Linear Combination of atomic Orbitals

(Formation of MOs) A.O + A.O → (MO)

INA = Z

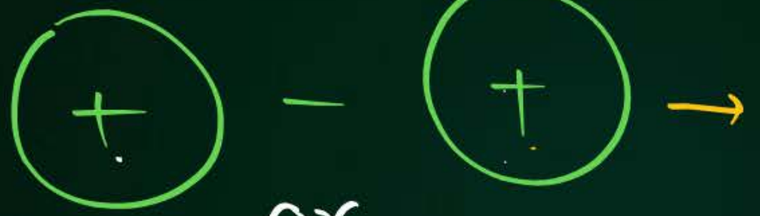


S+S



σ1S / σ2S

σ BMO



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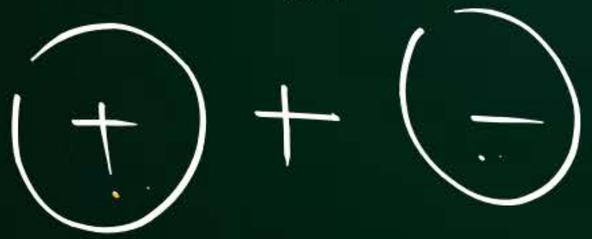
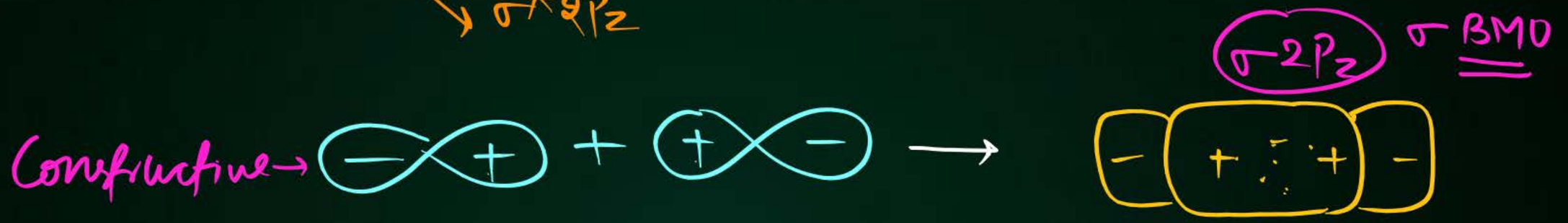


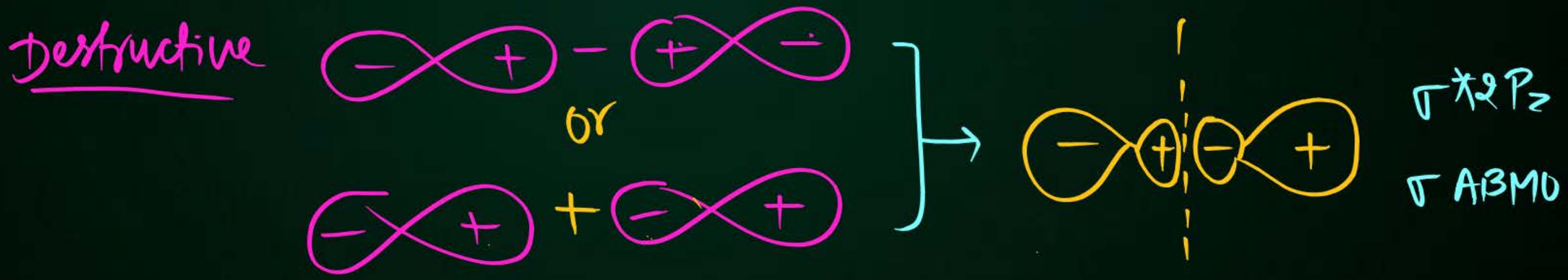
σ*1S / σ*2S

σ ABMO.

P + P Coaxial (INA = 2)

$p_z + p_z \rightarrow \sigma 2p_z$, $\sigma^* 2p_z$

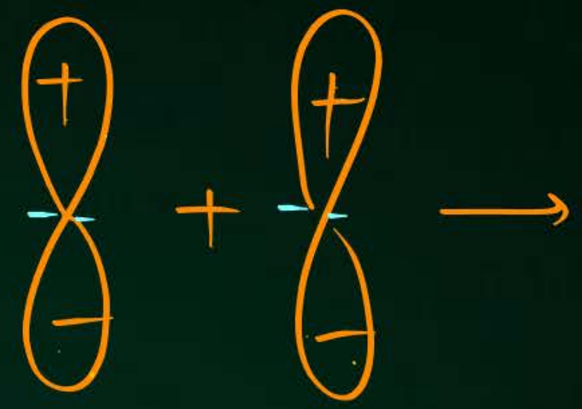


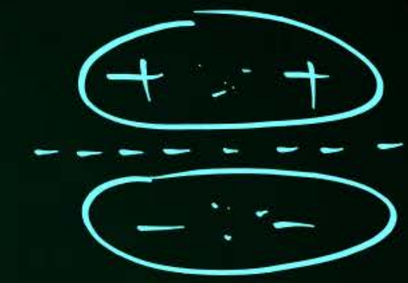


P+P (Sidewways)

$P_x + P_x$ → $\pi 2P_x$, $\pi^* 2P_x$

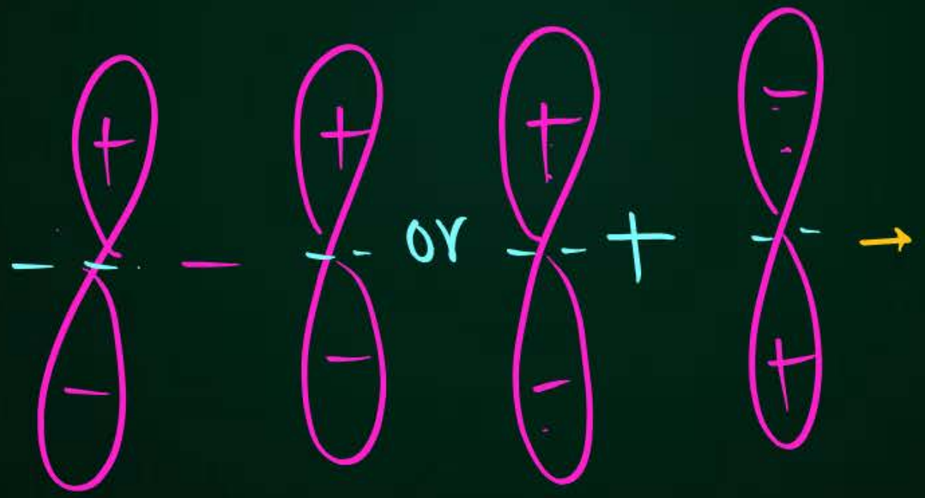
$P_y + P_y$ → $\pi 2P_y$, $\pi^* 2P_y$

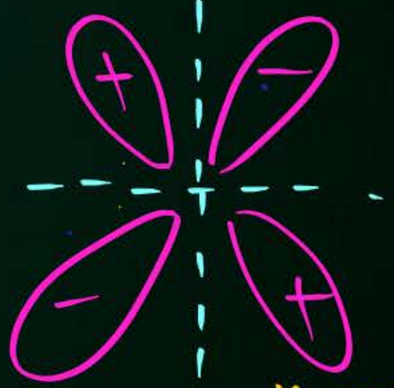




$\pi 2P_x$ / $\pi 2P_y$

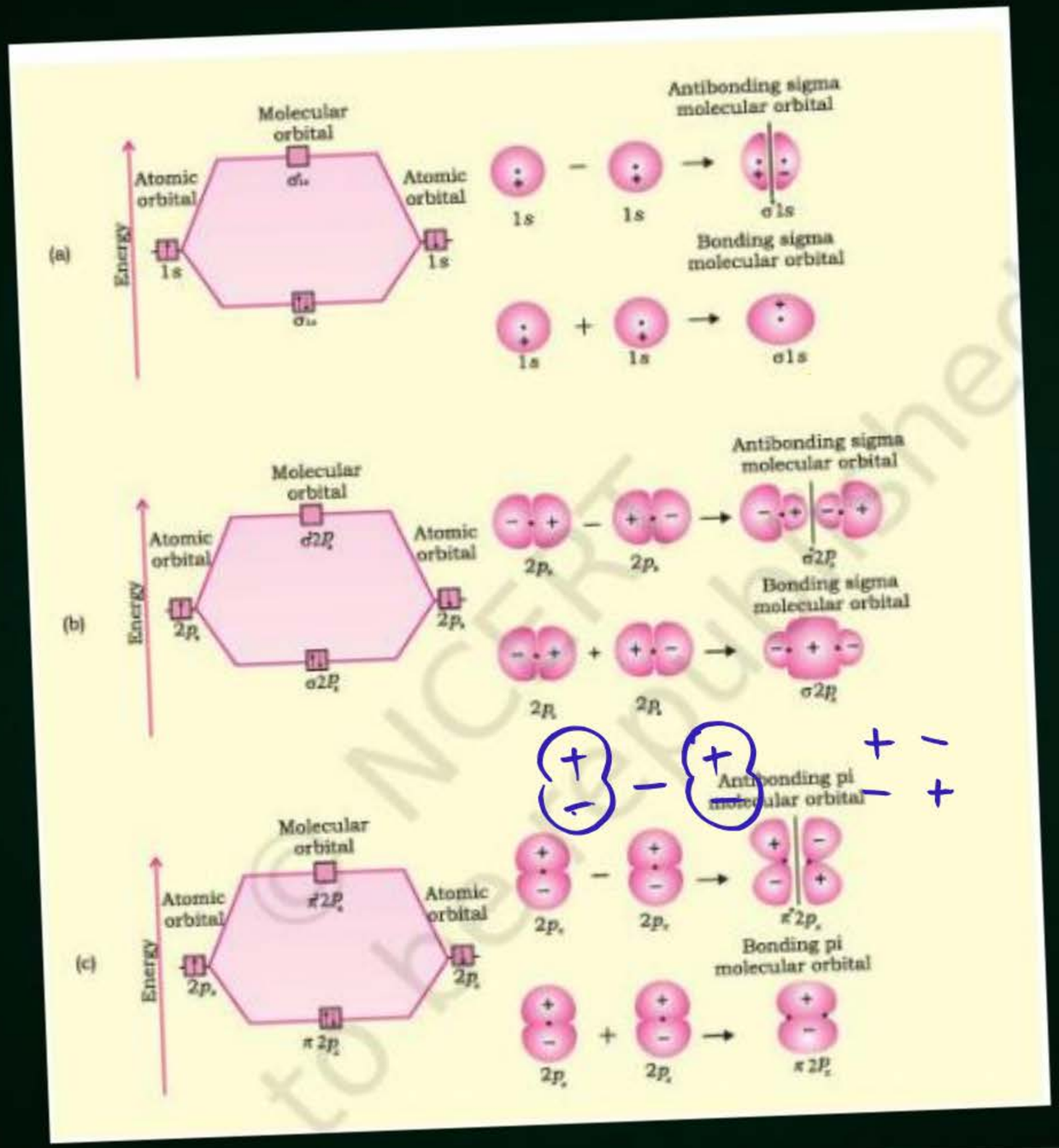
π BMO





$\pi^* 2P_x$ / $\pi^* 2P_y$

π ABMO


(a)
Molecular orbital
Atomic orbital
Atomic orbital
Energy
1s
1s
σ1s
σ*1s
Antibonding sigma molecular orbital
Bonding sigma molecular orbital
1s
1s
σ1s
(b)
Molecular orbital
Atomic orbital
Atomic orbital
Energy
2p_z
2p_z
σ2p_z
σ*2p_z
Antibonding sigma molecular orbital
Bonding sigma molecular orbital
2p_z
2p_z
σ2p_z
(c)
Molecular orbital
Atomic orbital
Atomic orbital
Energy
2p_x
2p_x
π2p_x
π*2p_x
Antibonding pi molecular orbital
Bonding pi molecular orbital
2p_x
2p_x
π2p_x

QUESTION

1221 → For all → $\sigma 2p_z$, $\pi 2p_x$, $\pi 2p_y$

If s-p mixing of orbitals is absent in following molecule, then in which of the following molecule only σ-bond is present ?

1. B_2
2. C_2
3. N_2
4. O_2

B_2: $\uparrow\downarrow$ $\sigma 2p_z$

C_2: $\uparrow\downarrow$ $\sigma 2p_z$; $\uparrow$ $\pi 2p_x$; $\uparrow$ $\pi 2p_y$

N_2: $\uparrow\downarrow$ $\sigma 2p_z$; $\uparrow\downarrow$ $\pi 2p_x$; $\uparrow\downarrow$ $\pi 2p_y$

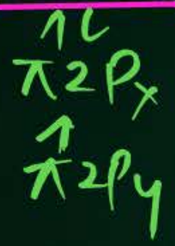
O_2: 2 ; $1\sigma + 1\pi$

1221 (Without s-p mixing) | 2121 (With s–p mixing)

QUESTION

In which of the following transformations, the bond order has increased and the magnetic behaviour has changed ?

1. $C_2^+ \rightarrow C_2$ (1.5 → 2.0; P → D)
2. $NO^+ \rightarrow NO$ (14 e⁻ → 15 e⁻; 3 → 2.5) ✗
3. $O_2 \rightarrow O_2^+$ (2.0 → 2.5; P → P) ✗
4. $N_2 \rightarrow N_2^+$ (3.0 → 2.5) ✗



QUESTION

Which of the following statement is correct ?

1. In the formation of dioxygen from oxygen atoms 10 molecular orbitals will be formed.
2. All the molecular orbitals in the dioxygen will be completely filled.
3. Total number of bonding molecule orbitals will not be same as total number of anti bonding orbitals in dioxygen.
4. Number of filled bonding orbitals will be same as number of filled anti bonding orbitals.

For O_2 (1221)

$8+8=16e^-$

$\sigma 1s < \sigma^* 1s < \sigma 2s < \sigma^* 2s < \sigma 2p_z < \pi 2p_x = \pi 2p_y < \pi^* 2p_x = \pi^* 2p_y < \sigma^* 2p_z$

$\pi 2p_x$: ↑↓ ; $\pi 2p_y$: ↑↓ ; $\pi^* 2p_x$: ↑ ; $\pi^* 2p_y$: ↑

QUESTION

Correct order of bond length is :

$B.L \propto \frac{1}{B.S/B.O}$

1. $O_2 < O_2^+ < O_2^-$
2. $O_2^+ < O_2 < O_2^-$
3. $O_2^- = O_2^+ < O_2$
4. $O_2 < O_2^+ = O_2^-$

H.W

QUESTION

Which of the following has maximum unpaired e^-

1. O_2 $n=2$
2. N_2 $n=0$
3. O_2^- $n=1$
4. O_2^{2-} $n=0$

Magnetic Moment & no. Unpaired e^-

$\mu = \sqrt{n(n+2)}$

(n=2)

$\sqrt{2(2+2)}$

$\sqrt{8}$

MDJ M.M (μ) = $\cap$ point Something

n=2 $\mu = 2.\ldots$

n=1 $\mu = 1.\ldots$

QUESTION

Which of the following has only π bonds -

1. N_2
2. B_2
3. C_2
4. Both (2) & (3)

QUESTION

Which pair of diatomic species have same bond order ?

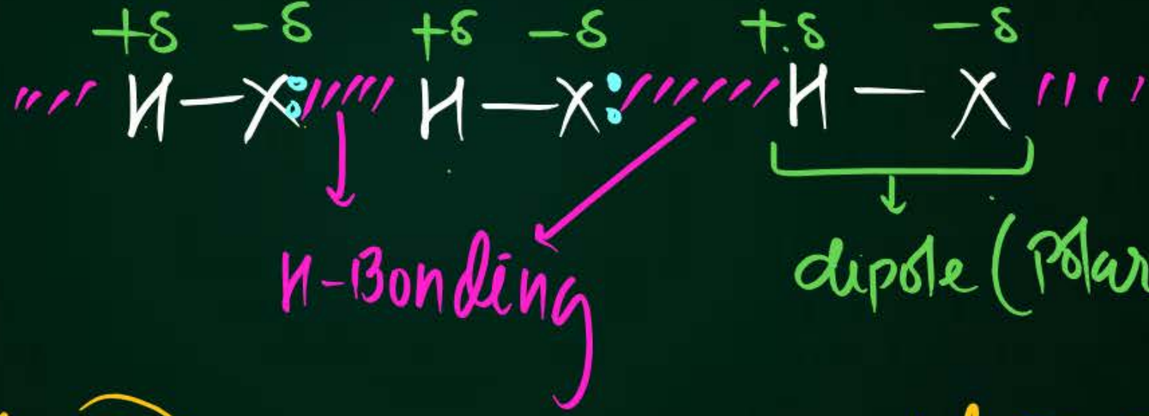
1. B_2^-, C_2
2. O_2^{2-}, F_2^-
3. N_2^+, O_2^-
4. B_2^{2-}, C_2

H.W

Hydrogen Bonding

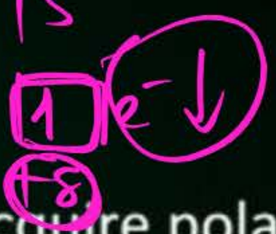
- When hydrogen is linked with high EN element like F/O/N, molecule acquire polarity and two adjacent molecules attract each other by H-bonding.

X = F/O/N

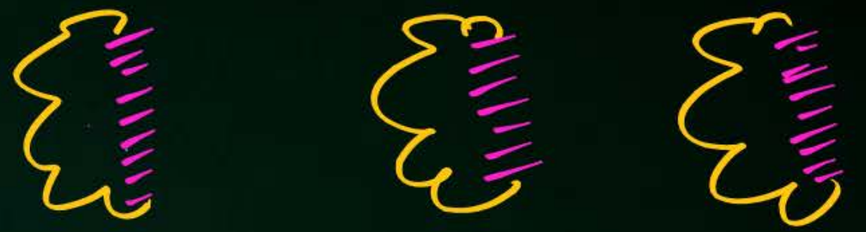


(NOTE) (1) H-Bonding is a special case of dipole-dipole Interaction

(2) l.p is essential For H-Bonding



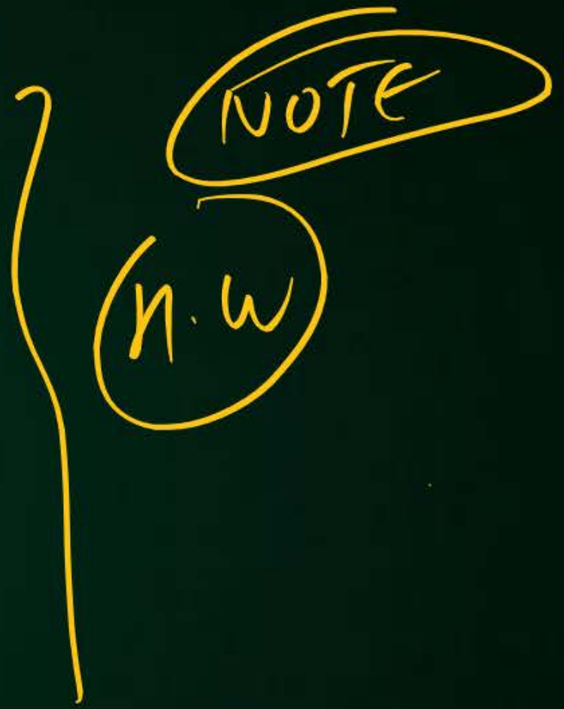
Classification H–Bonding



Intermolecular H-bonding	Intramolecular H-bonding
(i) Present b/w molecules	Present within molecule
(ii) Chelation (Ring) may occurs	Chelation always occurs (Ring Formation)
(iii) More association b/w molecules	Association b/w molecules is less
(iv) High M.P. & B.P.	Low M.P. & B.P.
(v) Less volatile (Low vapour pressure)	More volatile (Vapour pressure High)
(vi) Viscosity is more	Viscosity is less

Some Important points

1. Cellulose can show H-bonding with water.
2. Amino acid can show H-bonding with water
3. Water is liquid at room temp. while H_2S is gas.
4. Fire due to petrol can not be extinguish by water.
5. Fire due to alcohol can be extinguish by water.
6. Isomeric ethers are more volatile than alcohol.
7. High B.P. & viscosity can be explained by H-bonding.



Home work

True | False

1. $O_2^+ = O_2^-$ (Bond order)
2. $O_2^+ = O_2^-$ (Magnetic Moment)
3. $O_2 < N_2$ (ABMO e^-)
4. $O_2^+ < O_2^-$ (no. of unpaired e^-)
5. $N_2 < O_2$ (BMO e^-)
6. C_2 ($1\sigma + 1\pi$)
7. N_2 ($2\sigma + 1\pi$)
8. N_2^+ (Diamagnetic)
9. $N_2^+ = O_2^+$ (no. of Unpaired e^-)
10. $O_2^{2-} = O_2^+$ (no. of BMO e^-)

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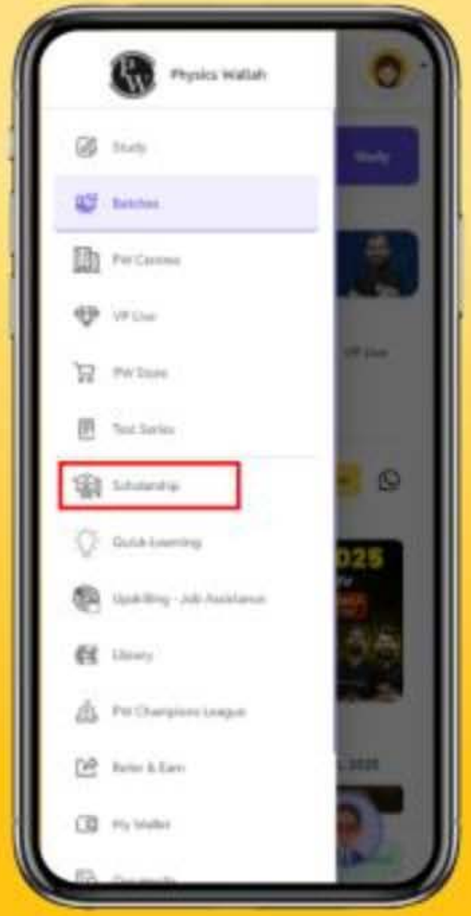

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Date
1 October 2024
Time
Duration
12:00 AM TO 11:59 PM 60 minutes
The exam will be proctored.
Candidates will be asked to turn on the camera and microphone as needed.
Candidates are suggested not to switch tabs on Desktop or App on Mobile during the test to avoid auto submission.
Candidature will be canceled if any candidate is found cheating during the examination.
Test Duration : 60 Minutes
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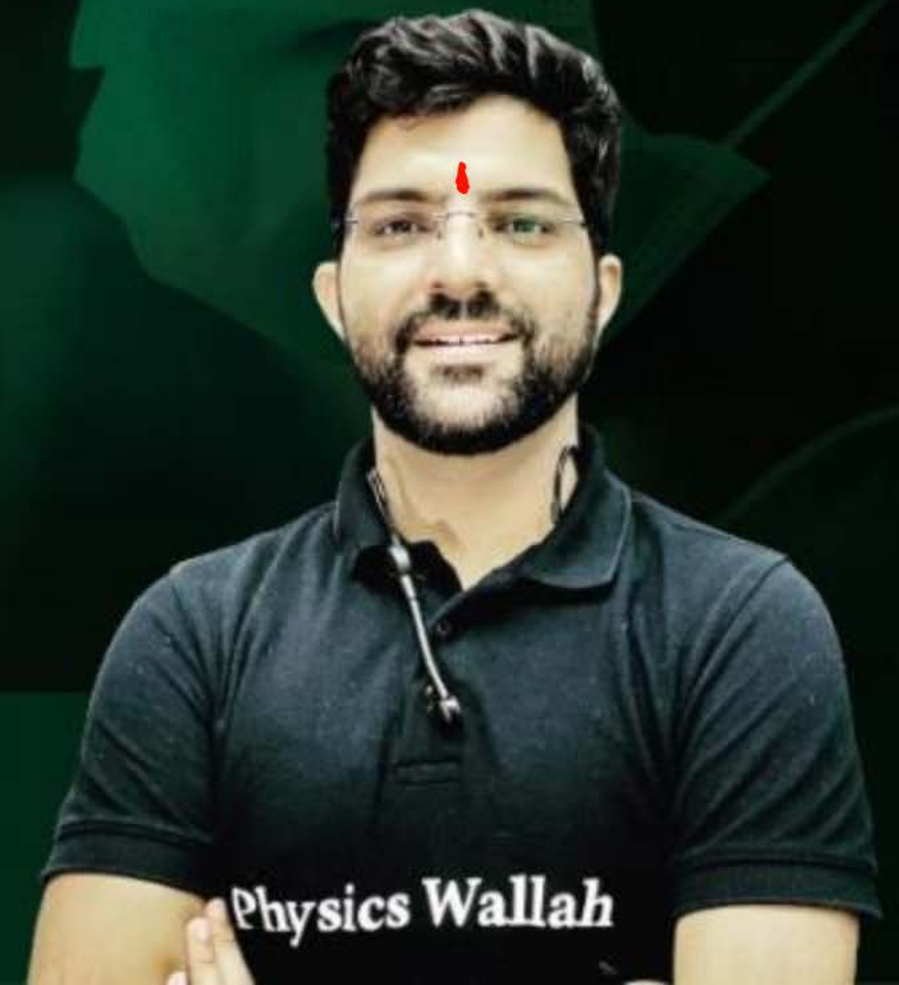
FOR NEET 2025

Lecture - 15 | Inorganic Chemistry

Chemical Bonding & Molecular Structure

By - Mohit Dadheech (MD Sir)



Topics *to be covered*

1. H-Bonding (Part-02)

Some Important points

No H-Bonding

H-Bonding (liquid)

1. Cellulose can show H-bonding with water. ✓
2. Amino acid can show H-bonding with water ✓
3. Water is liquid at room temp. while H_2S is gas. ✓
4. Fire due to petrol can not be extinguish by water. No H-Bonding b/w water & Petrol
5. Fire due to alcohol can be extinguish by water. H-Bonding b/w water & alcohol.
6. Isomeric ethers are more volatile than alcohol.

CH_3-O-CH_3 — H-Bonding ✗

C_2H_5-OH — H-Bonding ✓ less volatile.

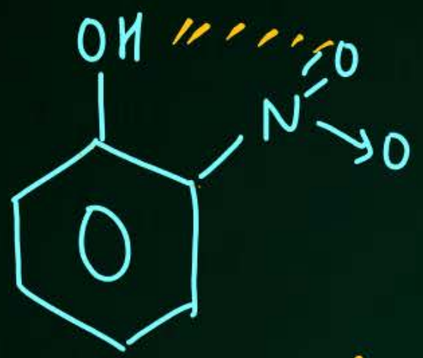
(M.F same)

7. (A) High B.P. & viscosity can be explained by H-bonding.

(B) High surface tension of water can be explained by H-bonding.

Imp

8. Ortho-Nitrophenol is more volatile than para-nitrophenol.



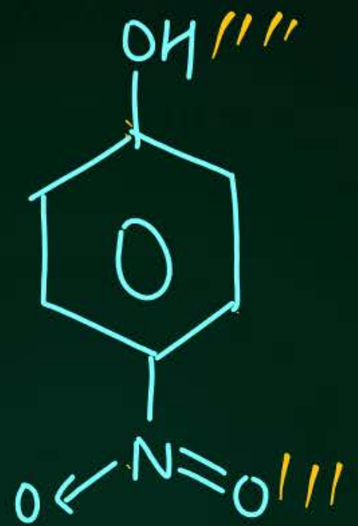
O-Nitrophenol

Intramolecular

less association

More volatile

less B.P



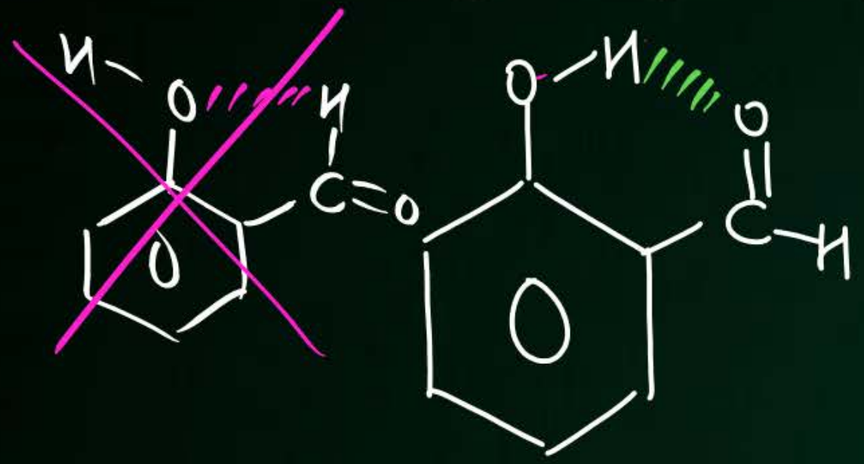
Inter molecular H-Bonding

More association b/w Molecules.

less Volatile.

More B.P

9. Ortho-Salicylaldehyde is liquid at room temp. while para-salicylaldehyde is solid.



Intra.

less association

liquid at room temp

Inter

More association

Solid at room temp

V.Imp

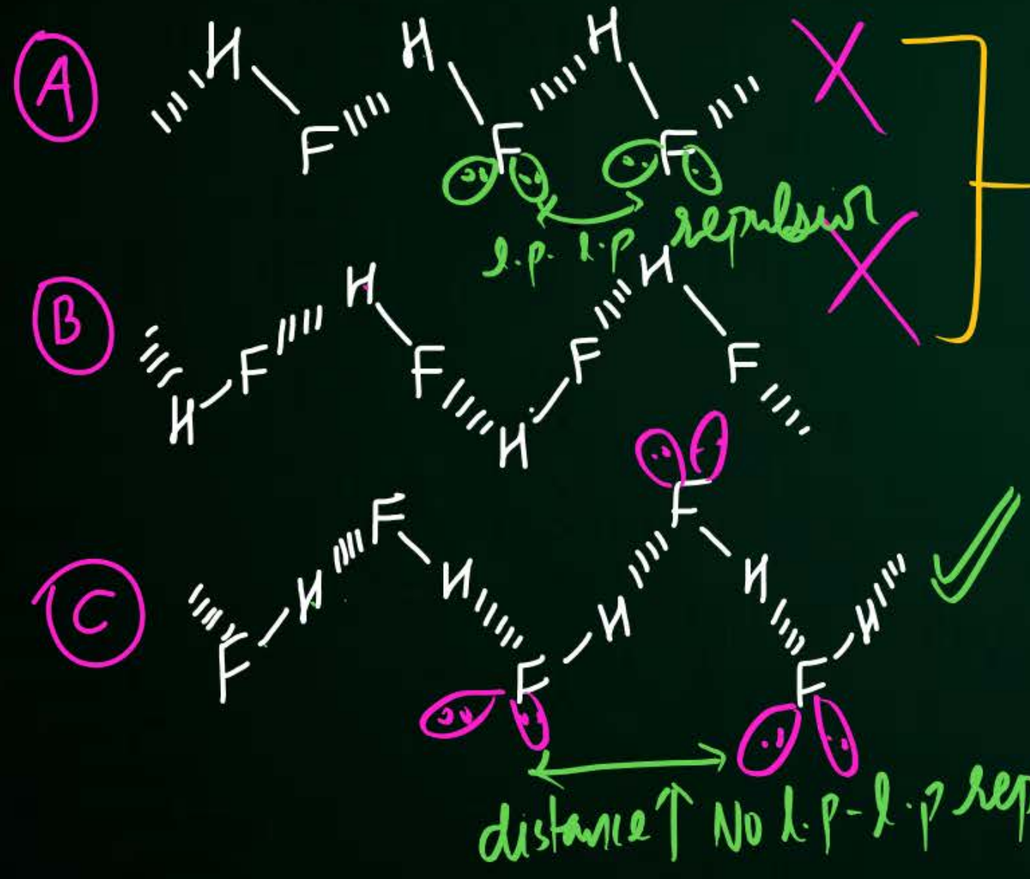
H-Bonding between HF Molecules :-

→ Strongest H-Bonding.

→ M.P & B.P is Higher than Expecations due to H-Bonding

* Zig-Zag Patkern

Intermolecular



Reasons

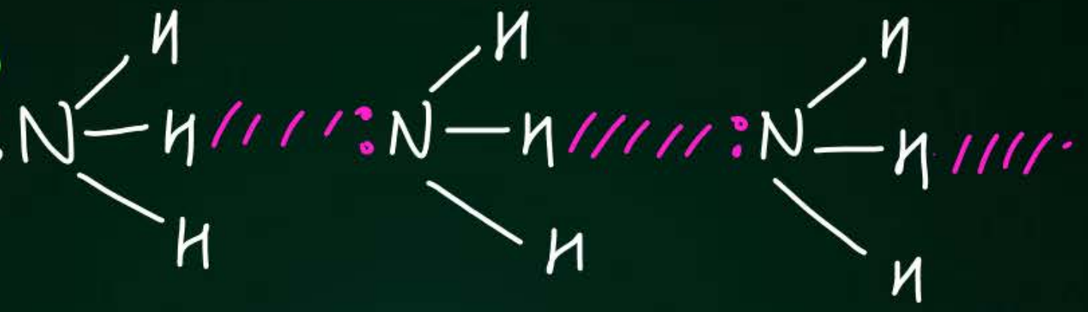
(i) H can not be present at Corner due to absence of l.p

(ii) l.p l.p Repulsion is High b/w F-F

H-Bonding in NH_3 :—

Intermolecular

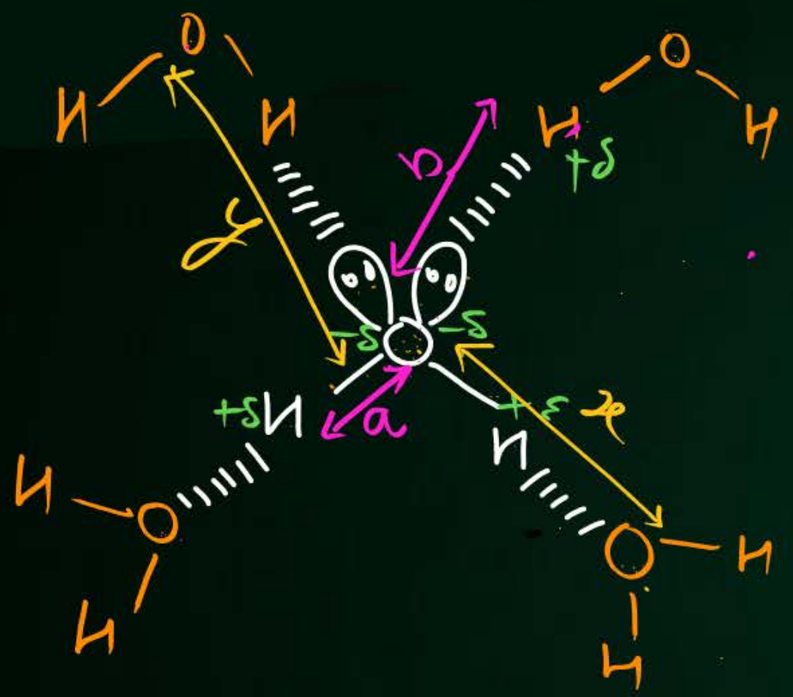
Avg no. of H-Bond in NH_3 = 2 (Bond Per Molecule)



* Closedpacking (Pyramidal) ✓

* due to H-Bonding M.P & B.P of NH_3 is Higher than Expectation among Other Hydrides of group 15th.

H-Bonding in $H_2O_{(s)}$ (Ice)



* Four sites involved in H-Bonding
* 3D H-Bonding (Intermolecular)
* Cage like structure (tetrahedral Void) (Khali Space)

due to Void Volume ↑se ∴ density ↓se in ice

on Heating Ice Contracts

↓

Volume ↓ Density ↑se

$\therefore d_{water} > d_{ice}$ (Ice floats on water)

* Oxygen of Central molecule :-
  (i) Surrounded by Four equidistant "H" ⇒ False ∵ $a < b$
  (ii) —"— —"— —"— —"— Oxygen True ($\because x = y$)

$H_2O_{(s)}$ Floats on $H_2O_{(l)}$ (T)

$D_2O_{(s)}$ Floats on $D_2O_{(l)}$ (T)

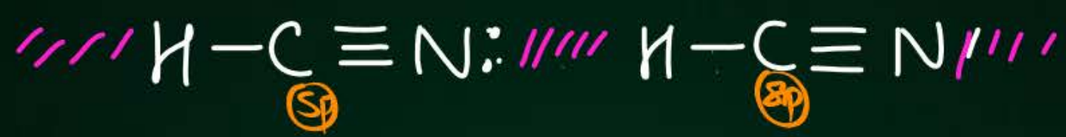
$D_2O_{(s)}$ Floats on $H_2O_{(l)}$ (F)

$H_2O_{(s)}$ Floats on $D_2O_{(l)}$ (T)

H-Bonding in HCN

linear

Intermolecular



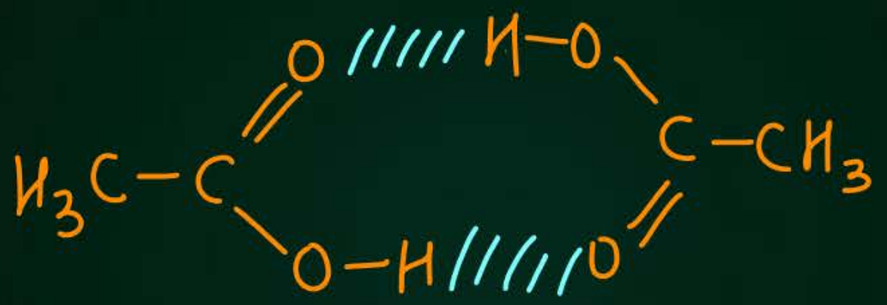
C_{sp} Hybridised EN = 3.25

In HCN, "H" is attached to C_{sp} Can show H-Bonding.

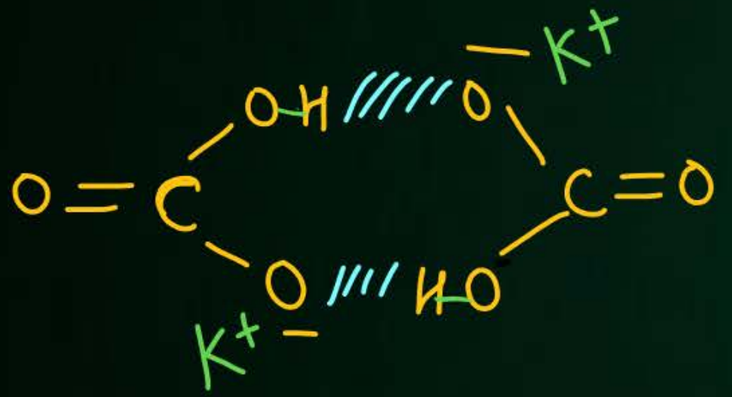
Dimer formation of CH_3COOH into Nonpolar solvent like Benzene

Reason- H-Bonding.

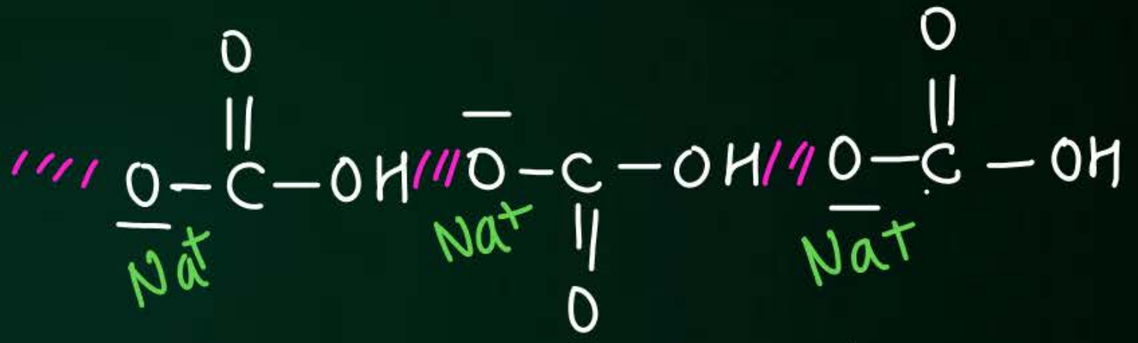
Inter Molecular



HCO_3^- (Bicarbonate ion) in $NaHCO_{3(s)}$ is present in polymeric form while in $KHCO_{3(s)}$ it can form only dimer.



In the Lattice of $KHCO_{3(s)}$ due to large size of K^+ ions HCO_3^- ions are far from each other. So it can form dimer only.



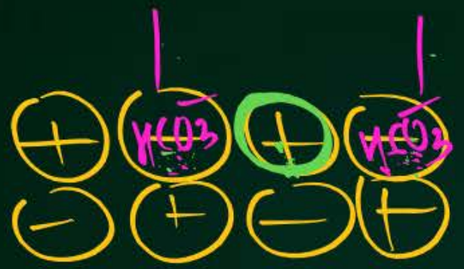
due to small size of Na^+ ions HCO_3^- ions are more closer to each other & polymerise easily.

(5) Lattice

K^+ } HCO_3^- ✓

Na^+ } HCO_3^- ✓

Ionic



$Na^+ < K^+$ (Size)

Strength & Extent of H-Bonding

Strength of H-Bond → Bond Energy of one H-Bond.

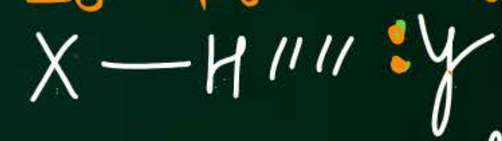
Extent of H-Bonding → number of H-Bonds per molecule.
(No. of sites)

Conditions For Stronger H-Bonding :—

(1.) Strongest H-Bonding ⇒ HF Molecules.

//// H—F //// H—F ////

(2.) For other Cases



↳ EN of X should be High

→ If X is same then EN of Y should be Low.

(More easy donation of l.p)

order of strength.

Ex $HF > H_2O > NH_3$

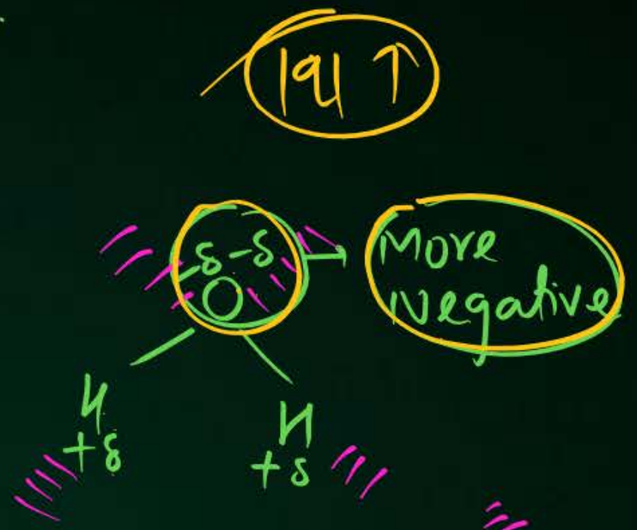
$H_2O > H_2O_2$

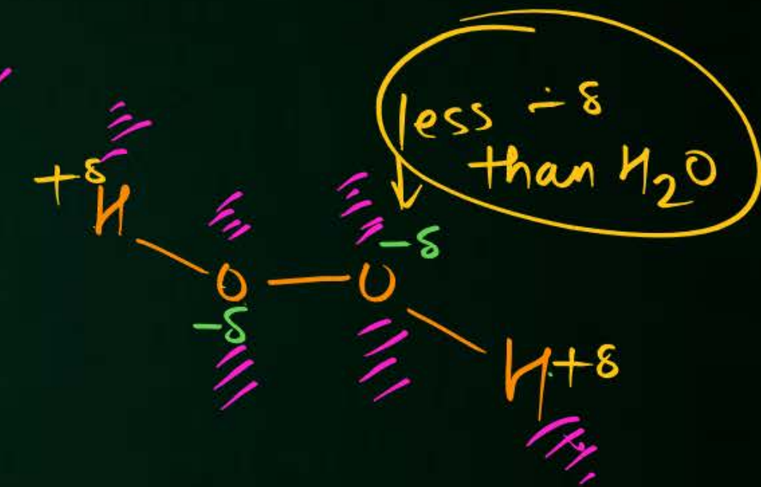
(EN of X) $O-H\cdots O > N-H\cdots N$

(X same) $N-H\cdots N > N-H\cdots O > N-H\cdots F$

Y EN↓ strength↑

$H_2O < D_2O < T_2O$





But

Extent

$H_2O < H_2O_2$

4 sites

6 sites

Order of B.P. & M.P. in group 15, 16, 17 hydrides

- M.P. & B.P. of group 15, 16 and 17 hydrides is mainly depends on weak Vander Waal force (W.V.F $\propto$ molecular weight) but M.P. & B.P. of NH_3, H_2O and HF is higher than expectation in their respective group due to presence of H-bonding.

BP

MD'J 2, 1, 1

Top to Bottom

NH_3 (2)	H_2O (1)	HF (1)
PH_3 4	H_2S 4	HCl 4
AsH_3 3	H_2Se 3	HBr 3
SbH_3 1	H_2Te 2	HI 2

according to M.W

(W.V.f ∝ M.W)

1 > 2 > 3 > 4

MP

MD'J 1 1 2

Top to Bottom

NH_3 (1)	H_2O (1)	HF (2)
4 PH_3	4 H_2S	4 HCl
3 AsH_3	3 H_2Se	3 HBr
2 SbH_3	2 H_2Te	1 HI

Strength of H-Bond

$HF > H_2O > NH_3$

Boiling Point order

$H_2O > HF > NH_3$

Melting Point order

$H_2O > NH_3 > HF$

NH_3 has More Close Packing in Solid

HF has Low Packing efficiency due to Zig-Zag

Voids are Large

QUESTION

The crystal lattice of ice is mostly formed by :

1. Ionic forces
2. Covalent bonds
3. Intra molecular H-bonds
4. Covalent as well as H-bonds

QUESTION

Intramolecular H-bond :

1. Decreases volatility
2. Increases melting point
3. Increases viscosity
4. None of these

QUESTION

Which of the following hydrides has the lowest B.P. -

1. H_2O
2. H_2S
3. H_2Se
4. H_2Te

QUESTION

The correct order of strength of H-bond in the following compound :

1. $H_2O > H_2O_2 > HF > H_2S$
2. $HF > H_2O_2 > H_2O > H_2S$
3. $HF > H_2O > H_2S > H_2O_2$
4. $HF > H_2O > H_2O_2 > H_2S$

Homework

Module - 1

Questions Based on

MOT & H-Bonding.

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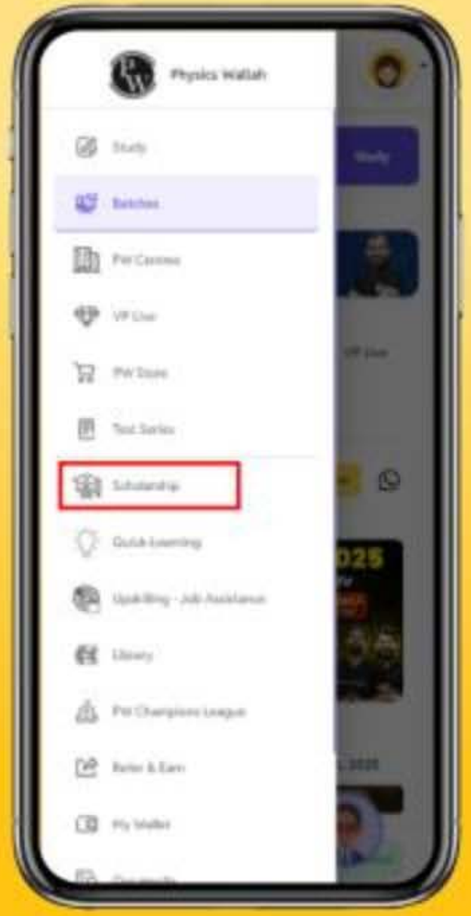

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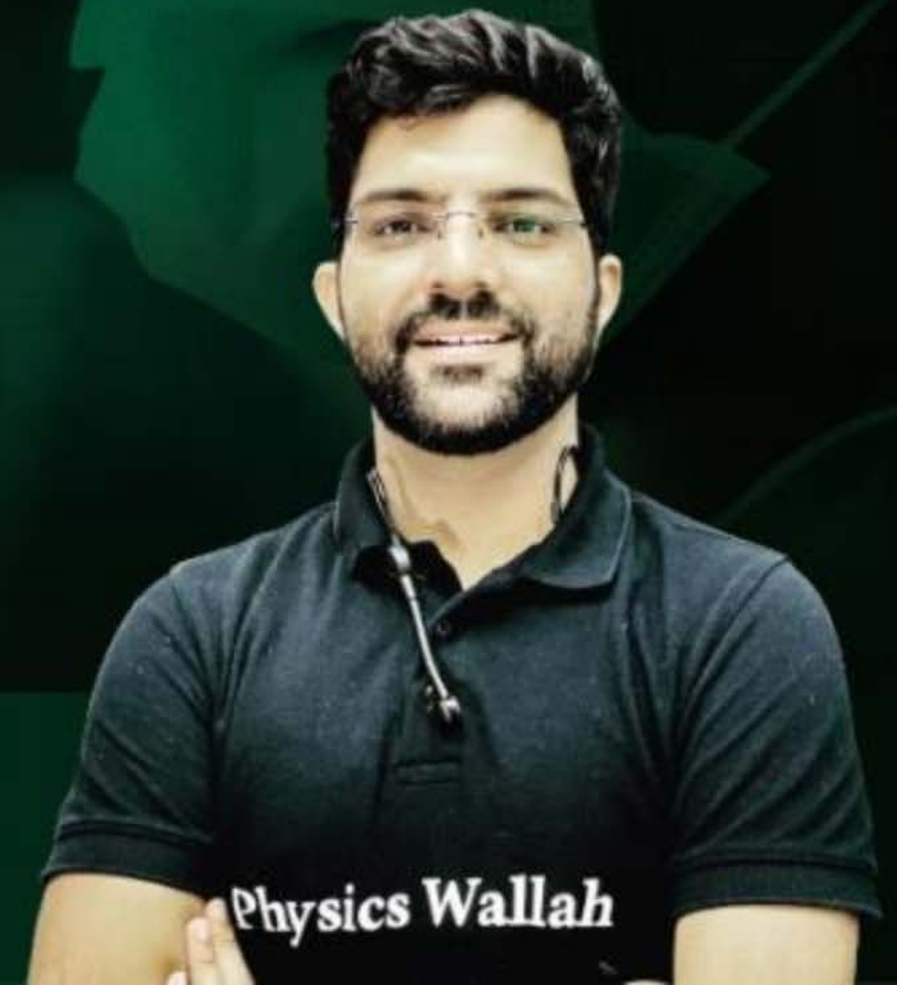
FOR NEET 2025

Lecture - 16 | Inorganic Chemistry

Chemical Bonding & Molecular Structure



By - Mohit Dadheech (MD Sir)

Topics *to be covered*

1. Dipole Based Forces
2. NCERT Scrutinizing

[Top to bottom]

15th	16th	17th
NH_3	H_2O	HF
PH_3	H_2S	HCl
AsH_3	H_2Se	HBr
SbH_3	H_2Te	HI

E-H Bond length ↑se

E-H Bond strength ↓se

E-H Bond dissociation Enthalpy ↓se

H^+ donation tendency in aq. medium ↑se

↳ Acidic Nature ↑se

⇒ H removal tendency ↑se
(oxidation tendency ↑se)

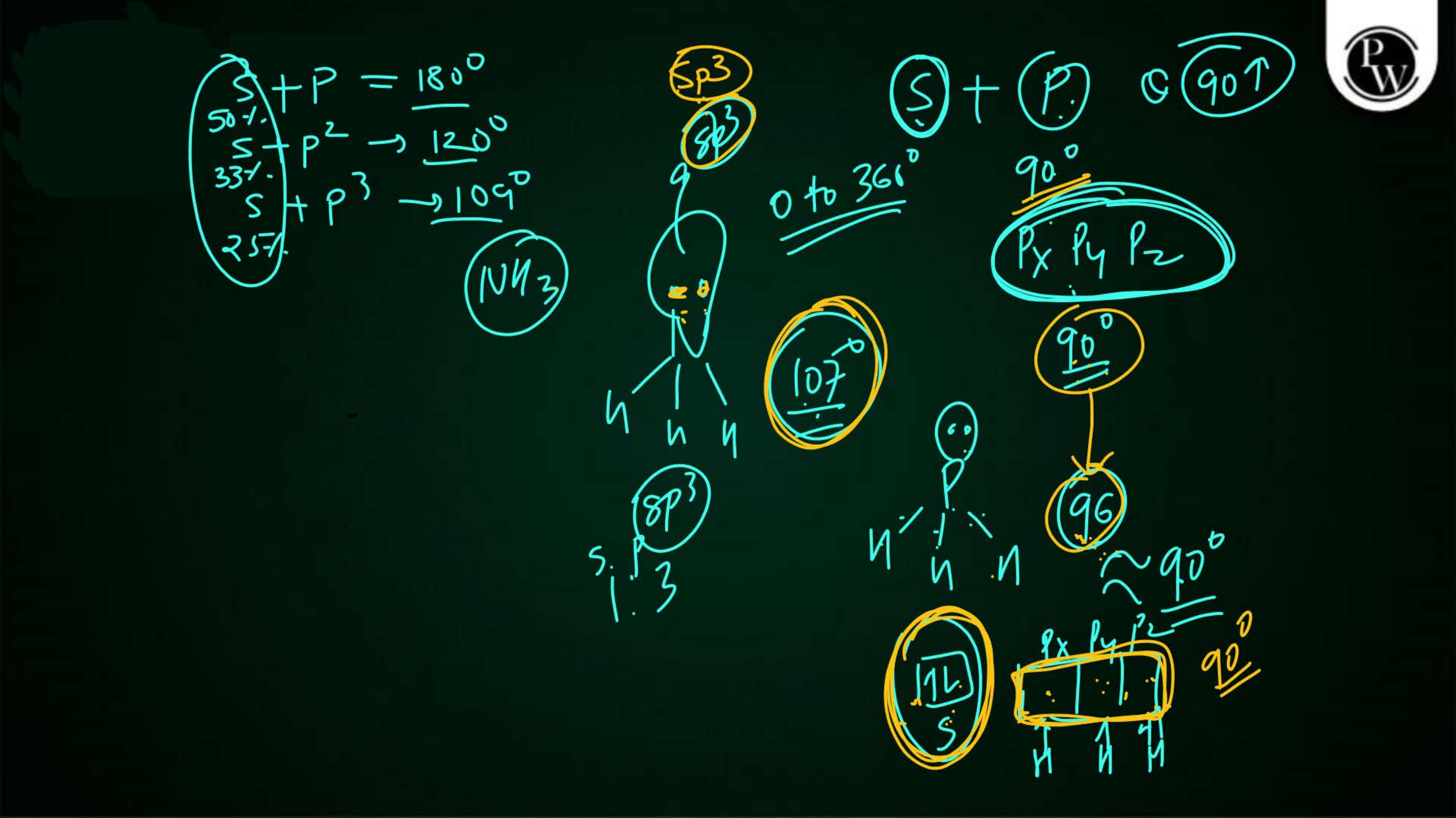
↳ Reducing Nature ↑se.

Only For 15th & 16th

Bond Angle → ↓se

Lewis basic Nature → ↓se

L.P directional nature → ↓se


s + p = 180°
50%
s + p² → 120°
33%
s + p³ → 109°
25%
NH3
sp3
sp3
0 to 361°
107°
8p3
s. p
1. 3
s + p. ⊙ 90↑
90°
Px Py Pz
90°
96
~90°
~90°
90°
11L
s

Dipole based Forces

~~Vanderwaal Force~~

Ions involved

(1) Ion-dipole

Resposible For association b/w ions & Polar Mole

(2) Ion-Induced dipole

Responsible For association b/w ions & Non polar species.

Strength order :

1 > A > 2 > B > C

Vanderwaal Forces

Ions not involved

(A) Dipole-dipole (Keesom Force)

Resp. Association b/w Polar molecules.

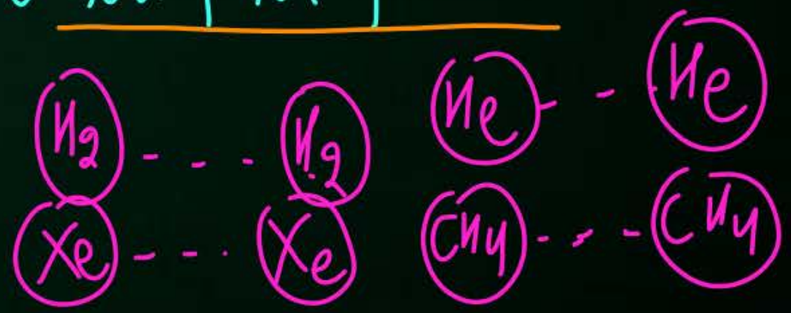
(B) Dipole-induced dipole (Debye)

Resp. Association b/w Polar & Non polar Molecules.

(C) Instantaneous dipole-induced dipole (Landon dispersion force)

Responsible → Association b/w Non polar species.

→ Weakest Bond.



Relation of Force & Interaction energy

Strength $1 > A > 2 > B > C$

Force

$F \propto \frac{1}{r^3}$ ID

$\propto \frac{1}{r^4}$ DD

$\propto \frac{1}{r^5}$ IID

$\propto \frac{1}{r^7}$ DLD

$\propto \frac{1}{r^7}$ IDID

3, 4, 5, 7 7

$E \propto \frac{1}{r^2}$

$\propto \frac{1}{r^3}$ In solid state

$\propto \frac{1}{r^4}$

$\propto \frac{1}{r^6}$

$\propto \frac{1}{r^6}$

liquid $E \propto \frac{1}{r^6}$

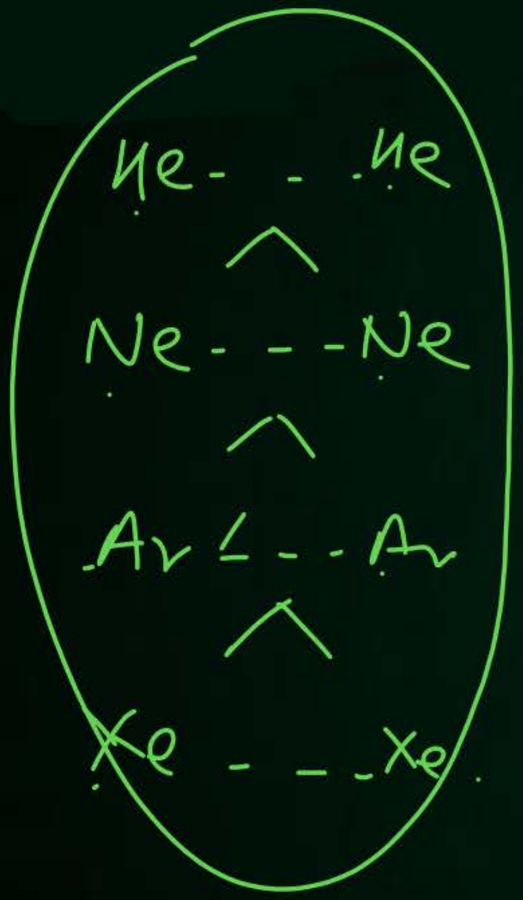
Type of Interactions present b/w Following Species :—

1. CH_4 --- CH_4 LDF
2. He --- He LDF
3. SnH_4 --- SnH_4 LDF
4. Xe --- Xe LDF
5. Li^+ --- H_2O ID
6. Na^+ --- H_2O ID
7. HCl --- HCl DD
8. Na^+ --- Br_2 ITD
9. Na^+_I --- $CS_{2\,NP}$ ITD
10. H_2O_P --- $Br_{2\,NP}$ DID
11. Br_2 --- Br_2 LDF
12. Cl_2 --- Cl_2 LDF
13. Na^+ --- Cl^- (Ionic Bond)
14. HF --- HF (Hydrogen Bond)
15. $CCl_{4\,NP}$ --- $CCl_{4\,NP}$ LDF
16. H_2S_P --- H_2S_P DD
17. NH_3 --- NH_3 (H-Bonding)
18. H_2O --- H_2O (H-Bonding)

Some Imp Points

* W.V.f $\propto$ M.W
* Responsible For Molecular Interactions.
  (atomic in Case of Noble gases)
* W.V.f also depend on physical state.
  S > L > G Gen

Imp. Properties of Inert gases Top to Bottom :-

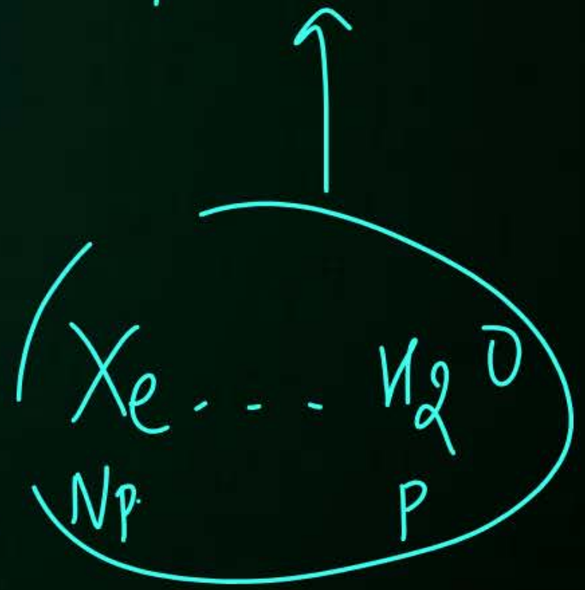


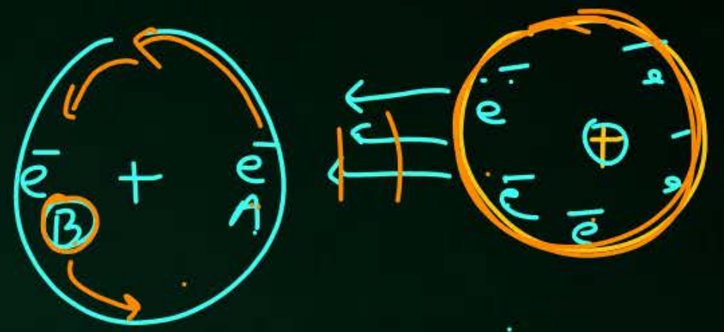
He
Ne
Ar
Kr
Xe ↓

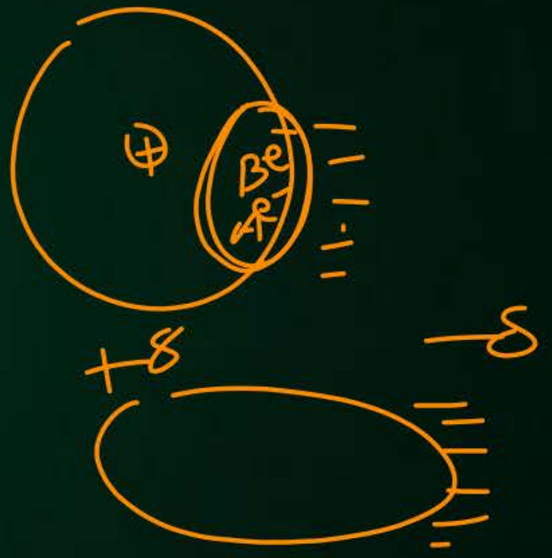
* Size ↑ → Surface area ↑
* I.E ↓
* M.W ↑
* W.V.f ↑

] M.W ↑, LDF ↑, DID ↑

* Solubility in water ↑se] decided by DID
* Real character ↑se
* Ideal character ↓se.
* Surface area ↑se.
* Adsorption tendency on charcoal Surface ↑se
* M.P ↑se
* B.P ↑se.




B


Be
+8
-8

QUESTION

The incorrect order of decreasing boiling points is :

1. $NH_3 > AsH_3 > PH_3$
2. $H_2O > H_2Se > H_2S$
3. $Br_2 > Cl_2 > F_2$
4. $CH_4 > GeH_4 > SiH_4$

NCERT KI CHOTI CHOTI MAGAR MOTI BAATEIN

VSEPR

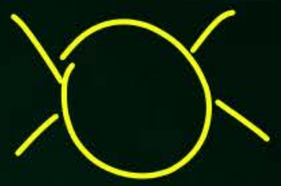
- The shape of a molecule depends upon the number of valence shell electron pairs (bonded or nonbonded) around the central atom.

$\sigma + l \cdot p$

- Pairs of electrons in the valence shell repel one another since their electron clouds are negatively charged.

- These pairs of electrons tend to occupy such positions in space that minimise repulsion and thus maximise distance between them.

- The valence shell is taken as a sphere with the electron pairs localising on the spherical surface at maximum distance from one another.



- A multiple bond is treated as if it is a single electron pair and the two or three electron pairs of a multiple bond are treated as a single super pair.

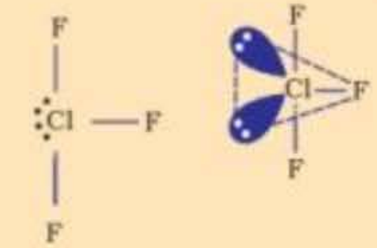
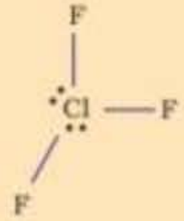
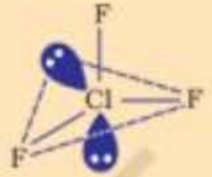
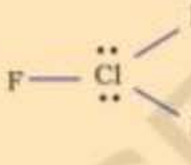
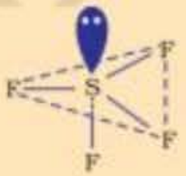
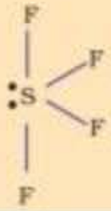
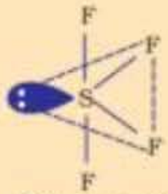
- Where two or more resonance structures can represent a molecule, the VSEPR model is applicable to any such structure.

- While the lone pairs are localised on the central atom, each bonded pair is shared between two atoms.

- As a result, the lone pair electrons in a molecule occupy more space as compared to the bonding pairs of electrons.

- This results in greater repulsion between lone pairs of electrons as compared to the lone pair - bond pair and bond pair - bond pair repulsions.

$l.p - l.p > l.p - b.p > b.p - b.p$

Molecule type	No. of bonding pairs	No. of lone pairs	Arrangement of electrons	Shape	Reason for the shape acquired
AB_3E_2	3	2	(a) 	T-shape	In (a) the lp are at equatorial position so there are less lp-bp repulsions as compared to others in which the lp are at axial positions. So structure (a) is most stable. (T-shaped).
			(b)  		
			(c) 		
AB_4E	4	1	(a) 	See-saw	In (a) the lp is present at axial position so there are three lp—bp repulsions at 90°. In(b) the lp is in an equatorial position, and there are two lp—bp repulsions. Hence, arrangement (b) is more stable. The shape shown in (b) is described as a distorted tetrahedron, a folded square or a see-saw.
			(b)   (More stable)		

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NOTES

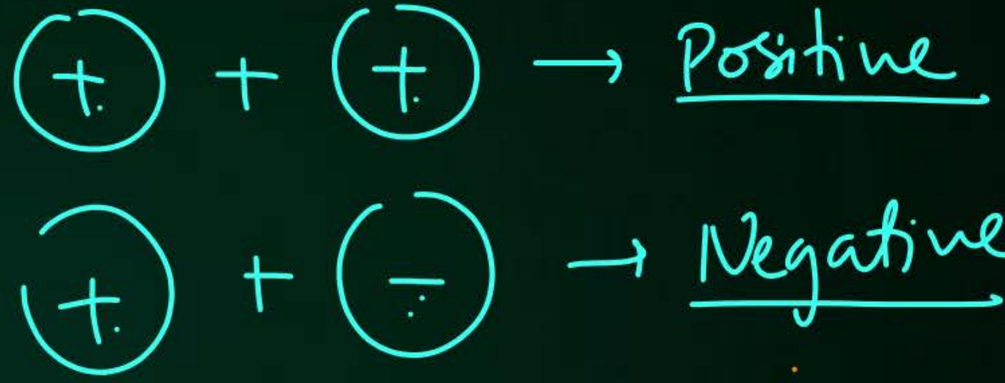
Formal charge

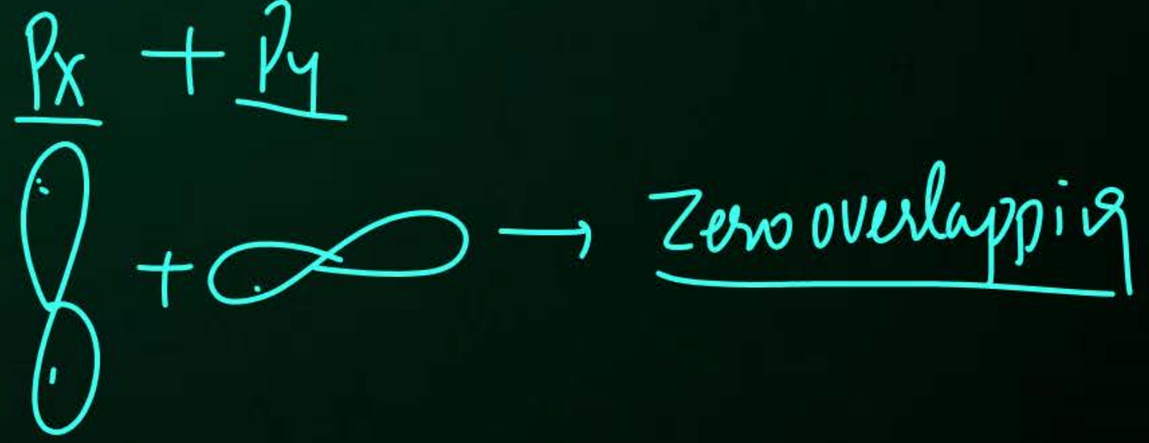
- Generally the lowest energy structure is the one with the smallest formal charges on the atoms. The formal charge is a factor based on a pure covalent view of bonding in which electron pairs are shared equally by neighbouring atoms.

(Overlapping)

- According to orbital overlap concept, the formation of a covalent bond between two atoms results by pairing of electrons present in the valence shell having opposite spins.

- Orbitals of two atoms come close to form bond, their overlap may be positive, negative or zero depending upon the sign (phase) and direction of orientation of amplitude of orbital wave function in space.





- Orbitals forming bond should have same sign (phase) and orientation in space. This is called positive overlap.

→ Positive

$p_x + p_x$ ✓

$p_x + p_y$ ✗

$p_z + p_z$ ✓

$p_z + p_x$ ✗

- The strength of a bond depends upon the extent of overlapping. In case of sigma bond, the overlapping of orbitals takes place to a larger extent. Hence, it is stronger as compared to the pi bond where the extent of overlapping occurs to a smaller extent. Further, it is important to note that in the formation of multiple bonds between two atoms of a molecule, pi bond(s) is formed in addition to a sigma bond.

Head on

B.S & Merging area

Collateral

Head on > Collateral

$\sigma > \pi$

(Hybridisation)

- [redacted] the atomic orbitals combine to form new set of equivalent orbitals known as hybrid orbitals. Unlike pure orbitals, the hybrid orbitals are used in bond formation. The phenomenon is known as hybridisation which can be defined as the process of intermixing of the orbitals of slightly different energies so as to redistribute their energies, resulting in the formation of new set of orbitals of equivalent energies and shape.

- In the periodic table, the highly electronegative halogens and the highly electropositive alkali metals are separated by the noble gases.

- The formation of a negative ion from a halogen atom and a positive ion from an alkali metal atom is associated with the gain and loss of an electron by the respective atoms.

- The negative and positive ions thus formed attain stable noble gas electronic configurations. The noble gases (with the exception of helium which has a duplet of electrons) have a particularly stable outer shell configuration of eight (octet) electrons, ns^2np^6.

- The negative and positive ions are stabilized by electrostatic attraction.

- The Small the size of the cation and the Large the size of the anion, the greater the covalent character of an ionic bond.

- The greater the charge on the cation, the greater the Covalent character of the ionic bond.

- Obviously ionic bonds will be formed more easily between elements with comparatively low ionization enthalpies and elements with comparatively high negative value of electron gain enthalpy.

H-Bonding

- Hydrogen bond can be defined as the attractive force which binds hydrogen atom of one molecule with the High EN atom of another molecule.

MOT

- Oxygen molecule contains two unpaired electrons in _____ molecular orbitals.

π^*2p_x & π^*2p_y or π ABMO

- Double bond in C_2 consists of both π bonds because of the presence of four electrons in two π BMO molecular orbitals.

($\pi 2p_x$ & $\pi 2p_y$)

- The molecule is stable if N_b is greater than N_a, and the molecule is unstable if N_b is less than N_a.

BMO e^- ABMO e^-

- If all the molecular orbitals in a molecule are doubly occupied, the substance is diamagnetic.

$n=0$

- If one or more molecular orbitals are singly occupied it is Paramagnetic

1 e^-

2|2|

- For B_2, C_2, N_2 energy of $\sigma 2p_z$ molecular orbital is greater than that of $\pi 2p_x$ and $\pi 2p_y$ molecular orbitals.

$\pi 2p_x$, $\pi 2p_y$ < $\sigma 2p_z$

- In the formation of bonding molecular orbital, the two electron waves of the bonding atoms reinforce each other due to _____ interference.

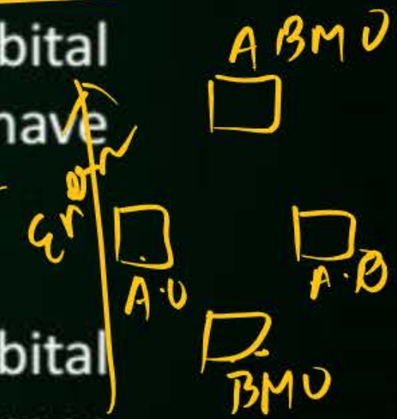
(Constructive)

- The electron density in a bonding molecular orbital is located between the nuclei of the bonded atoms because of which the repulsion between the nuclei is very less while in case of an antibonding molecular orbital, most of the electron density is located away from the space between the nuclei.

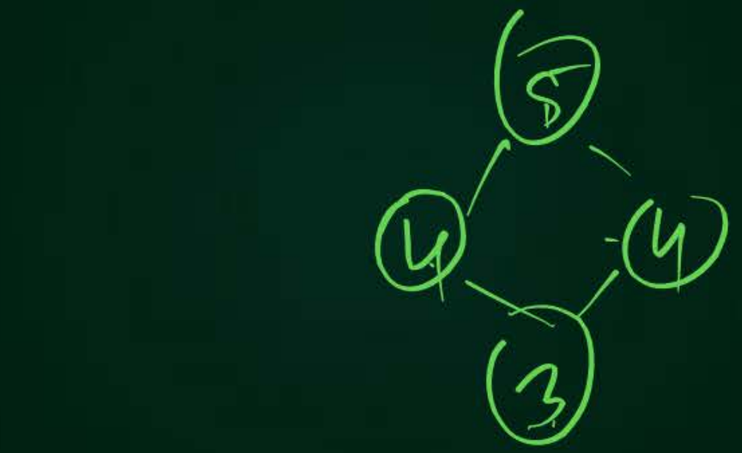
- Infact, there is a nodal plane (on which the electron density is zero) between the nuclei and hence the repulsion between the nuclei is high.

- Electrons placed in a bonding molecular orbital tend to hold the nuclei together and stabilise a molecule. Therefore, a bonding molecular orbital always possesses lower energy than either of the atomic orbitals that have combined to form it.

- In contrast, the electrons placed in the antibonding molecular orbital destabilise the molecule. This is because the mutual repulsion of the electrons in this orbital is more than the attraction between the electrons and the nuclei, which causes a net increase in energy.



- The energy of the antibonding orbital is raised above the energy of the parent atomic orbitals that have combined and the energy of the bonding orbital has been lowered than the parent orbitals. The total energy of two molecular orbitals, however, remains the same as that of two original atomic orbitals.



Total Energy = 8

- The combining atomic orbitals must have the same or nearly the same energy.

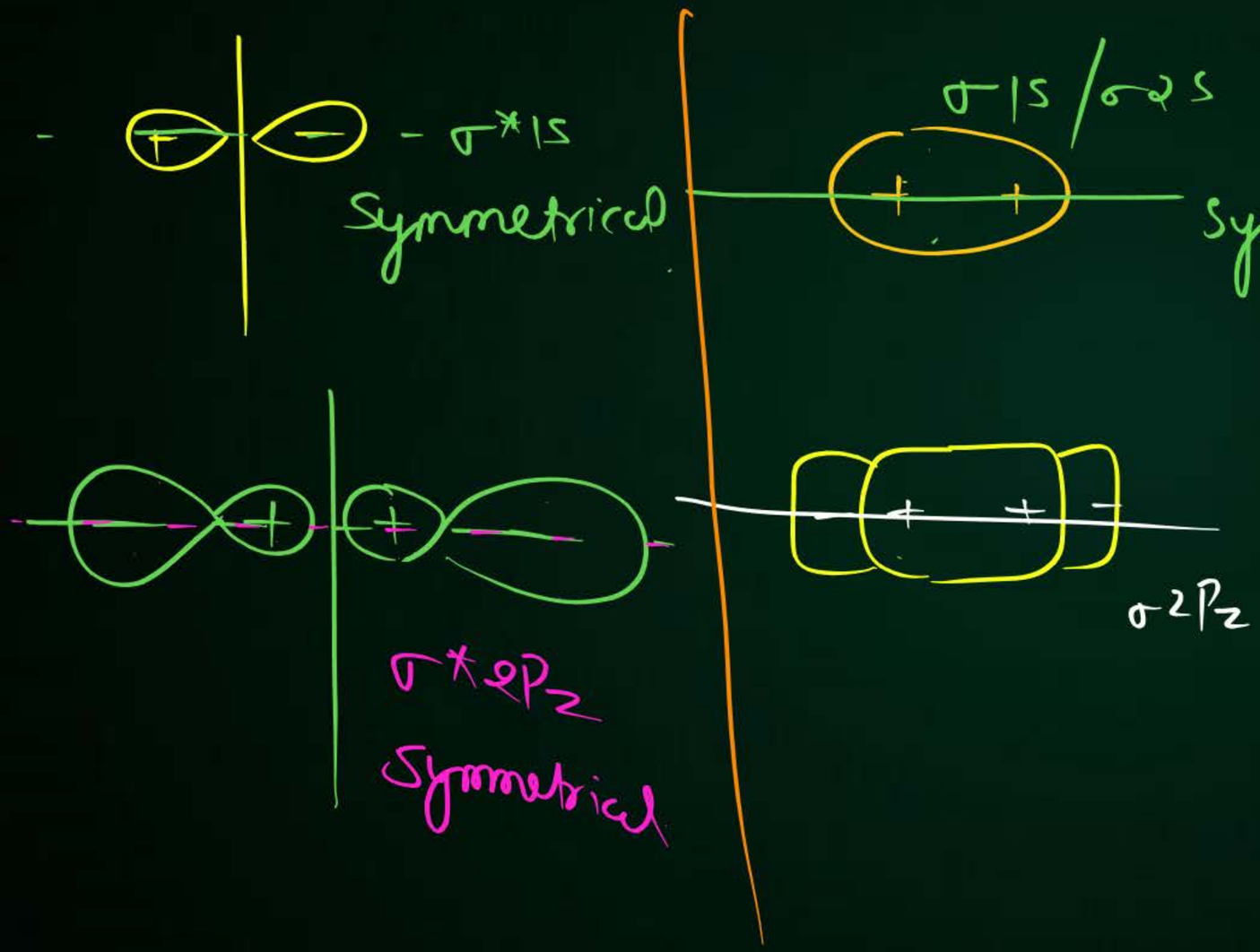
- The combining atomic orbitals must have the same symmetry about the molecular axis.

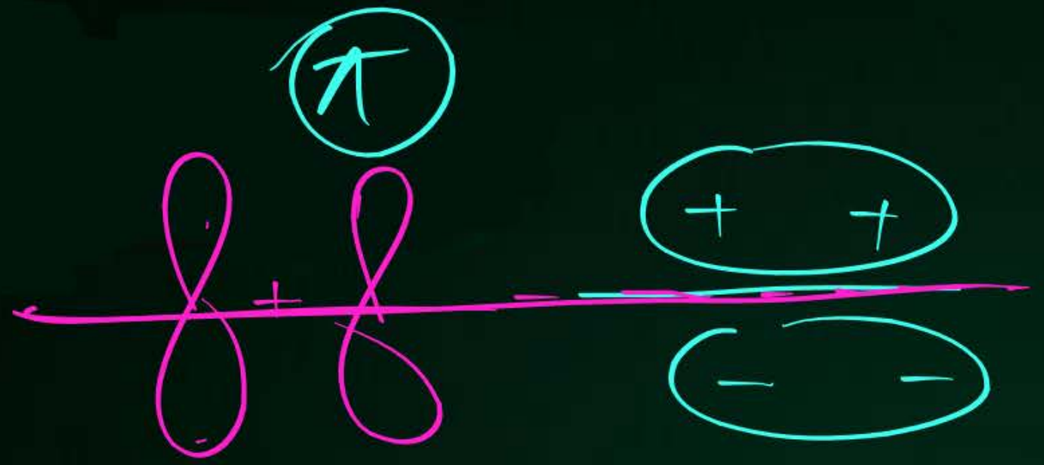
$p_x + p_x$ ✓

- The combining atomic orbitals must overlap to the maximum extent. ✓

- sigma (σ) molecular orbitals are symmetrical around the bond-axis while pi (π) molecular orbitals are not symmetrical.

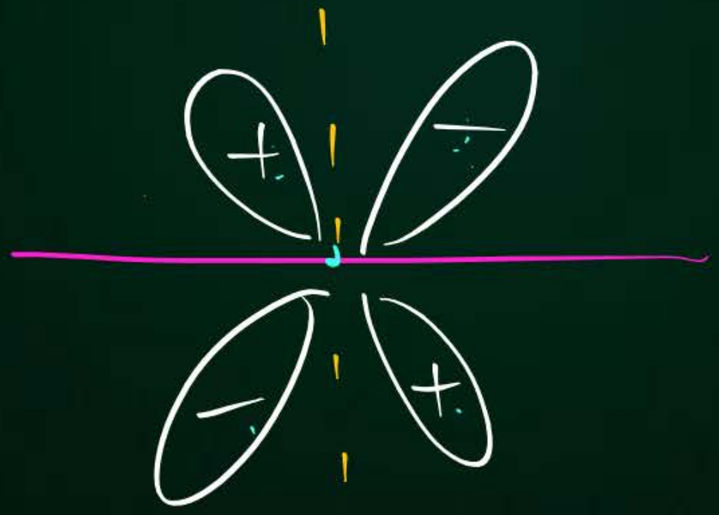
INA → According to NCERT (2)





$\pi 2p_x$ / $\pi 2p_y$

Unsymmetrical around Bond axis



$\pi^* 2p_x$ / $\pi^* 2p_y$

Unsymmetrical around Bond axis

- If internuclear axis is taken to be in the z-direction, it can be seen that a linear combination of $2p_z$ orbitals of two atoms also produces two sigma molecular orbitals designated as $\sigma 2p_z$ and $\sigma^* 2p_z$.

- Molecular orbitals obtained from $2p_x$ and $2p_y$ orbitals are not symmetrical around the bond axis because of the presence of positive lobes above and negative lobes below the molecular plane. Such molecular orbitals, are labelled as π and = π^*. A π bonding MO has larger electron density above and below the inter-nuclear axis. The π^* antibonding MO has a node between the nuclei.

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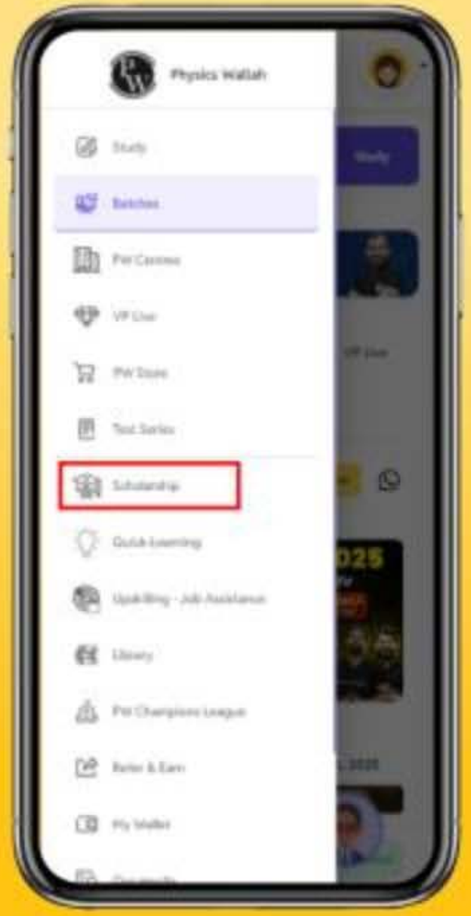

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Cohort	Class	Name of the Test	Exam Date	Mode	Physics	Chemistry	Botany	Zoology
NEET	11	Test 1	13-Oct-2024	Online	Basic Maths & Calculus (Mathematical Tools) Vectors Units and Measurements Motion in a straight line	Structure of Atom Some Basic Concepts of Chemistry Classification of Elements and Periodicity in Properties	Cell - The Unit of Life Cell Cycle and Cell Division	Structural Organization in Animals Breathing and Exchange of Gases

12th NEET REAL TEST SERIES SYLLABUS

Cohort	Class	Name of the Test	Exam Date	Mode	Physics	Chemistry	Botany	Zoology
NEET	12	Test 1	13-Oct-2024	Online	Electric Charges and Fields Electrostatic Potential and Capacitance	Solution Electrochemistry	Sexual Reproduction in Flowering Plant	Human Reproduction

DROPPER NEET REAL TEST SERIES SYLLABUS

Cohort	Class	Name of the Test	Exam Date	Mode	Physics	Chemistry	Botany	Zoology
NEET	Dropper	Test 1	13-Oct-2024	Online	Basic Maths & Calculus (Mathematical Tools) Vectors Units and Measurements Motion in a straight line Motion in a plane Circular motion Laws of motion	Some Basic Concept of Chemistry Redox Reaction Solutions Thermodynamics Equilibrium Electrochemistry	Cell - The Unit of Life Cell Cycle and Cell Division The Living World Biological Classification Plant Kingdom Morphology of Flowering Plants	Structural Organization in Animals Breathing and Exchange of Gases Body Fluids and Circulation Excretory Products & their Elimination

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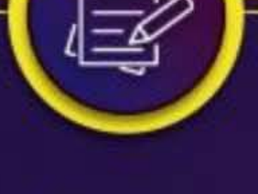

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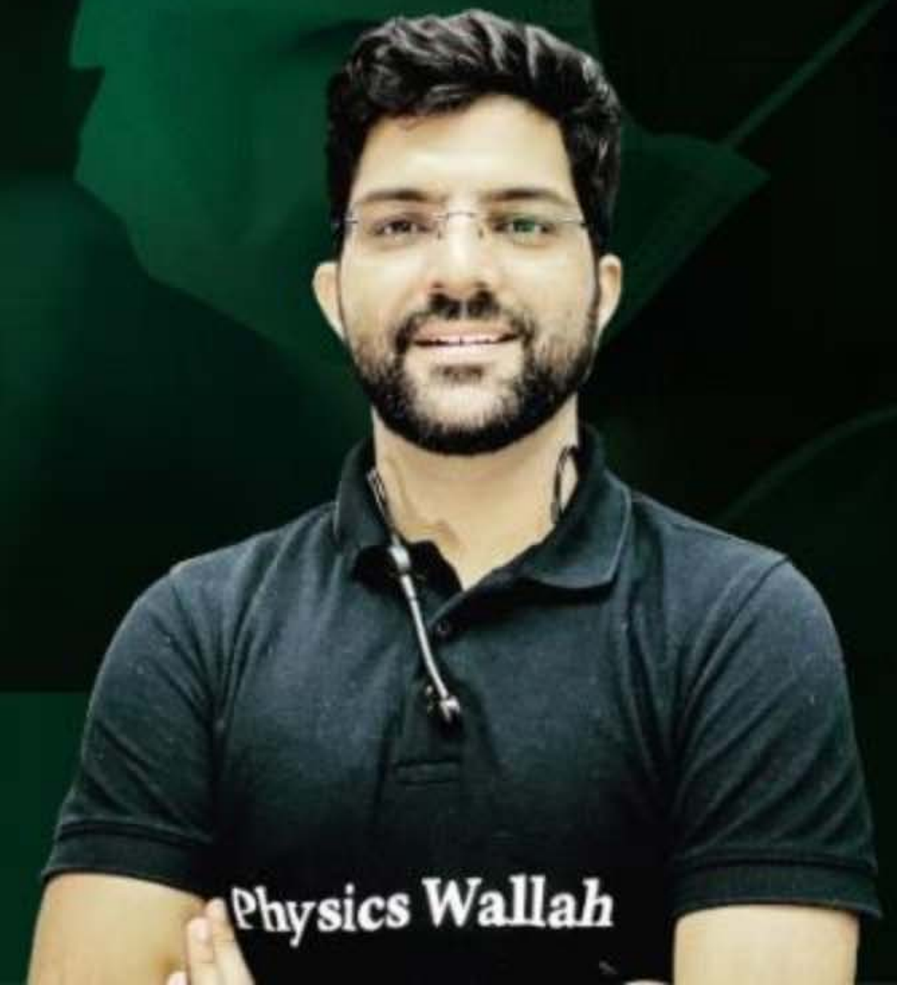
FOR NEET 2025

Lecture - 17 | Inorganic Chemistry

Chemical Bonding & Molecular Structure

By - Mohit Dadheech (MD Sir)



Topics *to be covered*

1. Practice Questions

QUESTION

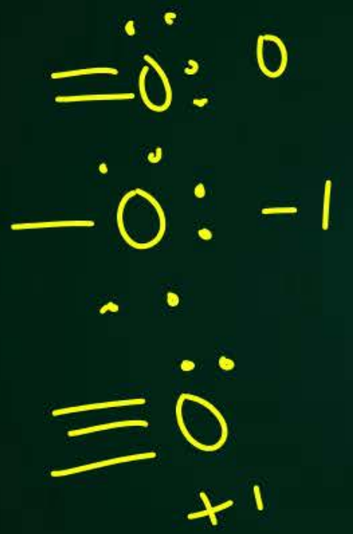
Which of the following Lewis dot structure of CO_2 is incorrect ?

1. :Ö – C ≡ O:

2. Ö = C = Ö

3. :O ≡ C – Ö:

4. None of these



QUESTION

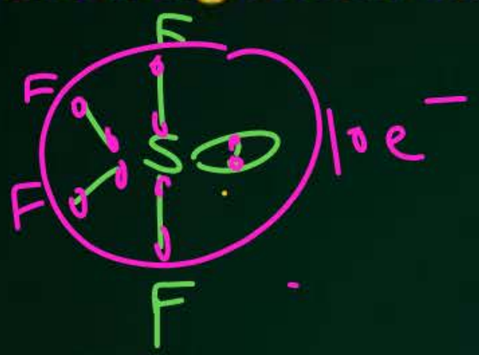
According to Lewis dot structure the number of bond pairs around central atom is greater than four for which of the following anion?

1. CO_3^{2-}
2. NO_3^-
3. PO_4^{3-}
4. None

QUESTION

Which of the following follow octet rule ?

1. SF_4
2. AlF_3
3. Boric acid
4. BCl_3

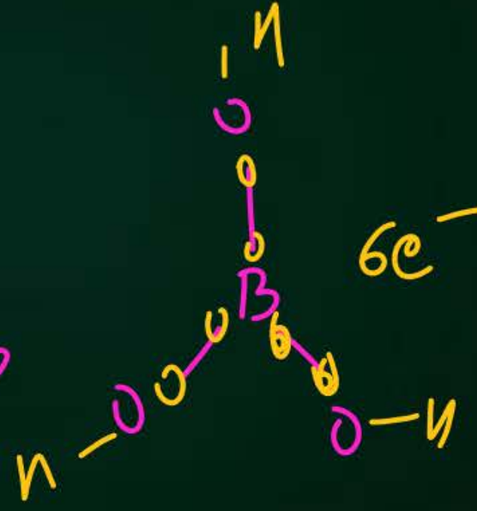


AlF_3 Ionic

Al^{3+} F^-

8e⁻ 8e⁻

$B(OH)_3$ or H_3BO_3



6e⁻

QUESTION

In which of the following species the bonds are non directional ?

Ionic

1. NCl_3 · sp^3
2. RbCl · Ionic ✓
3. $BeCl_2$ · sp
4. BCl_3 · sp^2

QUESTION

Which combination will give strongest ionic bond ?

1. Na^+ and Cl^-

2. Mg^{2+} and Cl^- ✗ $MgCl_2$ Cov. ch. ↑

3. Na^+ and O^{2-}

4. Mg^{2+} and O^{2-} ✓ $Mg^{+2}O^{-2}$ High L.E Strong Ionic Bond.

QUESTION

Amongst the following trihalides, which one is least basic?

1. NF_3
2. NCl_3
3. NBr_3
4. NI_3

Lewis Basis ∝ l·p donation

+δ ↑ ⟶ EN ↑ ⟶ l-p donation tendency ↓se

QUESTION

Which of the following statement is correct ?

1. PH_3 is more basic than NH_3
2. PH_3 is equally basic as NH_3 ✗
3. PH_3 is less basic than NH_3
4. PH_3 is amphoteric while NH_3 is basic ✗

NH_3
PH_3
AsH_3
SbH_3

l.p directional nature ↓

L.B.L.

(A) $\ddot{N}H_3 + H^+ \longrightarrow NH_4^+$

(B) $\ddot{P}H_3 + H^+ \longrightarrow PH_4^+$

which reaction is fast ⇒

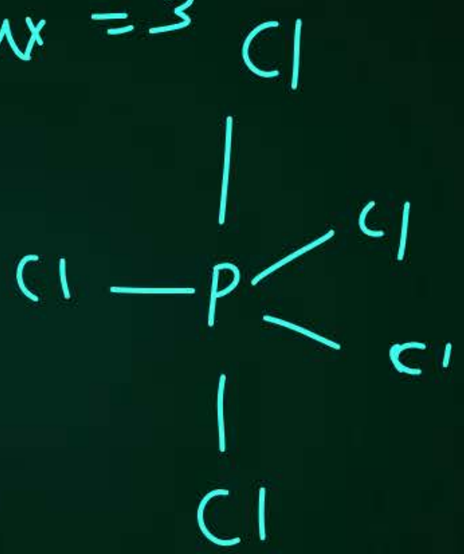
(A)

QUESTION

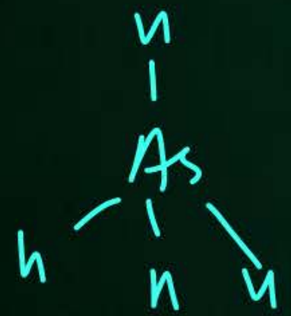
In which of the following species maximum atom lie in same plane ?

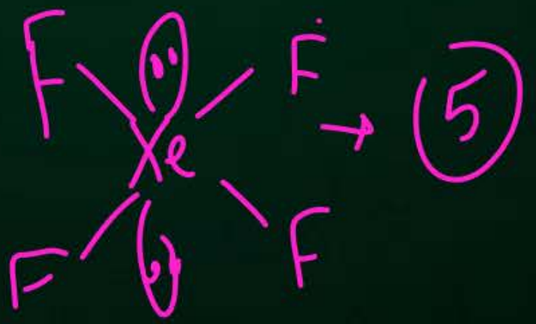
1. XeF_2O_2
2. PCl_5
3. AsH_4^+
4. XeF_4

Max = 3



Max = 4





QUESTION

In which of the following molecular shape dz^2-orbital must not be involved in bonding ?

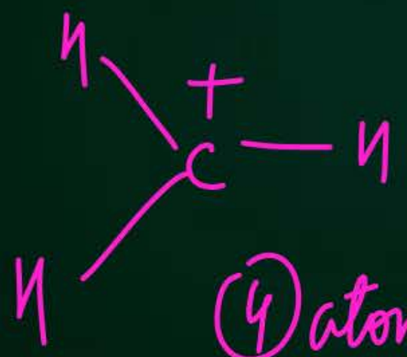
1. Pentagonal planar
   (AB_5L_2) sp^3d^3
2. Trigonal planar
   AB_3L_0 sp^2
3. Linear
   AB_2L_0 (sp) & AB_2L_3 (sp^3d)
4. Square planar
   AB_4L_2 sp^3d^2

QUESTION

According to VSEPR theory, in which spices do all the atoms lie in the same plane ?

1. CH_3^+ 2. CH_3^-

1. 1 only
2. 2 only
3. Both 1 and 2
4. Neither 1 nor 2



(4) atom

T. Planar.

QUESTION

Which of the following orbitals can not undergo hybridization ?

(i) 3d, 4s (ii) 3d, 4d (iii) 3d, 4s & 4p (iv) 3s, 3p & 4s

1. only ii
2. ii & iv
3. ii & iii
4. i, ii & iv

3d 4s 4p 4d

Inner d Complexes

d^2sp^3

dsp^3

dsp^2

3d 4s 4p 4d

outer d complexes

sp^3d^2

sp^3d

Hybridisation → Energy gas should be Minimum

2s 2p

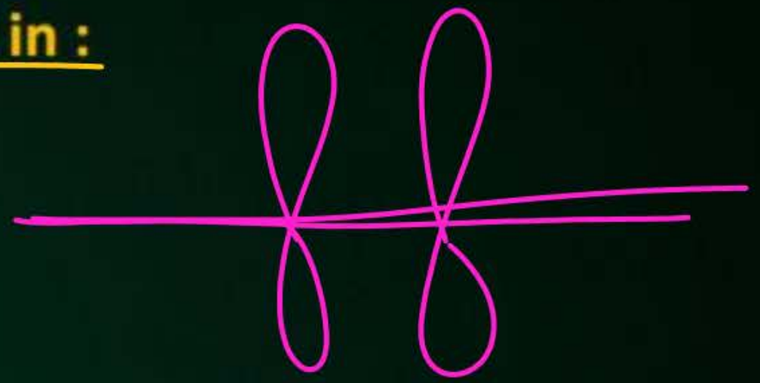
3s 3p

3s 3p 3d

4s 4p

QUESTION

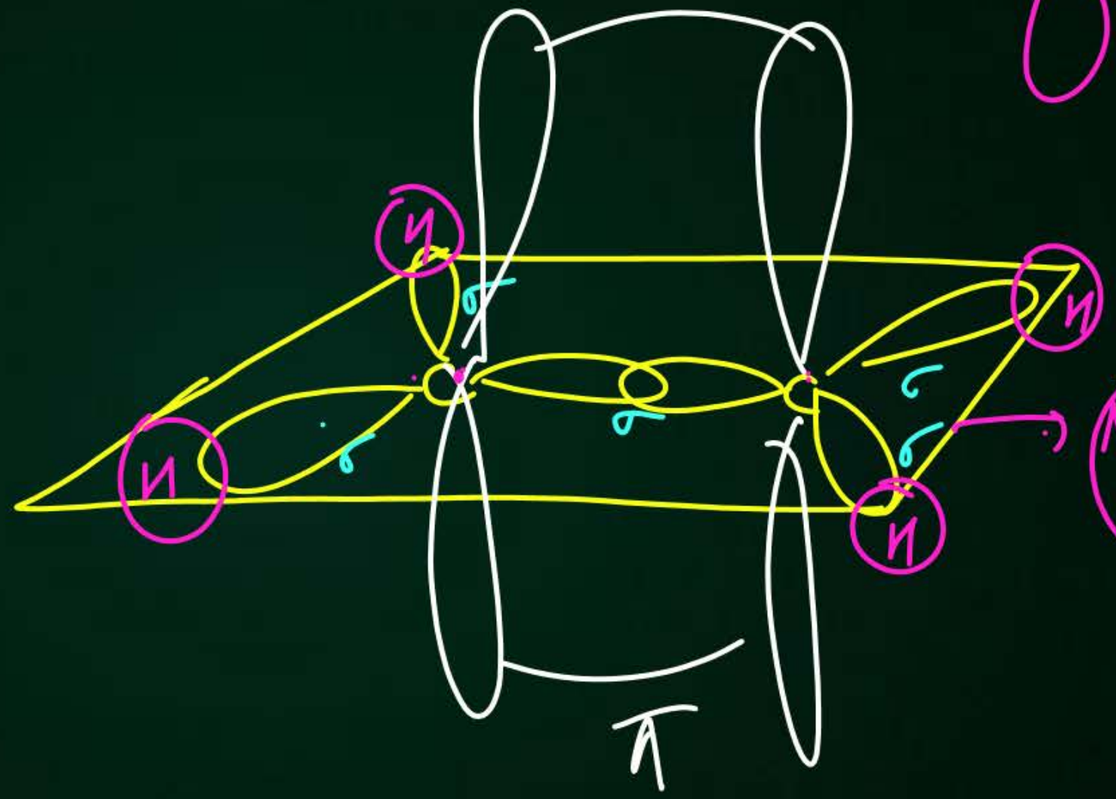
The nodal plane in the π-bond of ethene is located in :

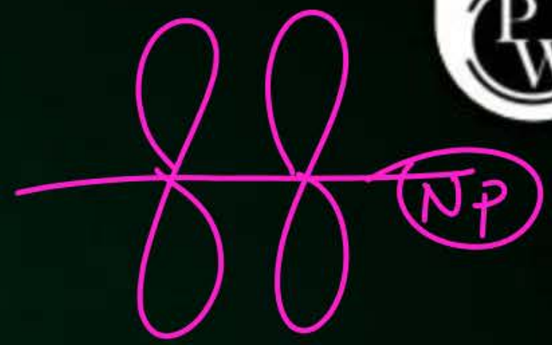


1. The molecular plane
2. A plane parallel to the molecular plane
3. A plane perpendicular to the molecular plane which bisects the carbon-carbon σ bond at right angle
4. A plane perpendicular to the molecular plane which contains the carbon-carbon bond

$CH_2 = CH_2$

sp^2 sp^2





σ & π

Perpendicular to each other.

QUESTION

$SiF_4 + HF \longrightarrow [SiF_6]^{2-}$ or $H_2[SiF_6]$

(Si in SiF_4: sp^3; Si in $[SiF_6]^{2-}$: sp^3d^2)

$SiF_4 + HF \rightarrow$ No Rxn

In which reaction, hybridization of underlined atom remains unchanged ?

1. Combustion of $\underline{CH_4} \rightarrow CO_2$

(C in CH_4: sp^3; C in CO_2: sp)

2. Solidification of $\underline{PCl_5}$ vapour

(P in PCl_5: sp^3d)

$PCl_5 \rightarrow$ solid $\left\langle \begin{array}{l} PCl_4^+ \ (sp^3) \\ PCl_6^- \ (sp^3d^2) \end{array} \right.$

3. SiF_6 vapour is passed through liq. HF

4. $\underline{Al(OH)_3}$ ppt, dissolve in NaOH

$Al(OH)_3 + OH^- \longrightarrow Al(OH)_4^-$

(Al in $Al(OH)_3$: sp^2; Al in $Al(OH)_4^-$: sp^3)

$NaOH + Al + H_2O \rightarrow Al(OH)_3 + OH^- \rightarrow Na[Al(OH)_4]$

QUESTION

Which of the following xenon compound has the same number of lone paris as in I_3^- ?

at C.A

I_3^- AB_2L_3

1. XeO_4 AB_4L_0
2. XeF_4 AB_4L_2
3. XeF_2 AB_2L_3
4. XeO_3 AB_3L_1

QUESTION

The lowest O – O bond length in the following molecule is :

1. O_2F_2
2. O_2
3. H_2O_2
4. O_3

B.O = 1

O_2 = 2

H_2O_2 = 1

O_3 1.5

QUESTION

Select the correct statement :

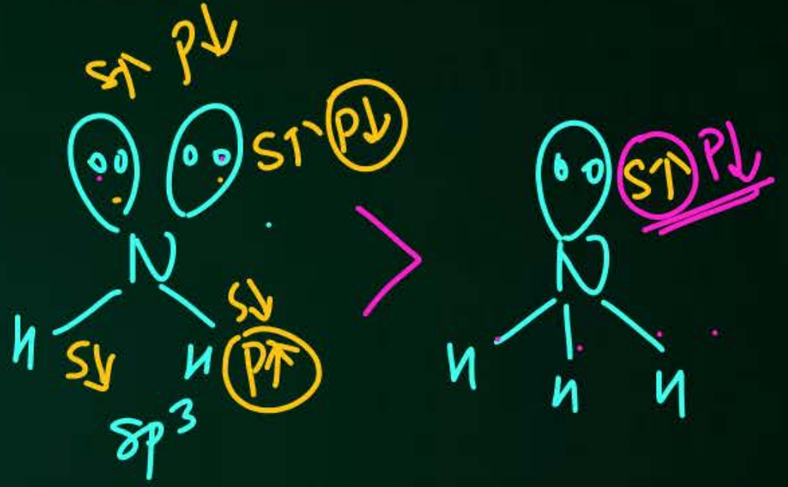
1. B–F bond length in $BF_3 > BF_4^-$ ✗ (sp^2 vs sp^3)

2. N–H bond length in $NH_3 > NH_2^-$ (sp^3 vs sp^3)

3. P–H bond length in $PH_3 > PH_4^+$ ✓

Negligible mixing of 3s

4. C–H bond length in $CH_3^+ > CH_4$ ✗ (sp^2 vs sp^3)



PH_3

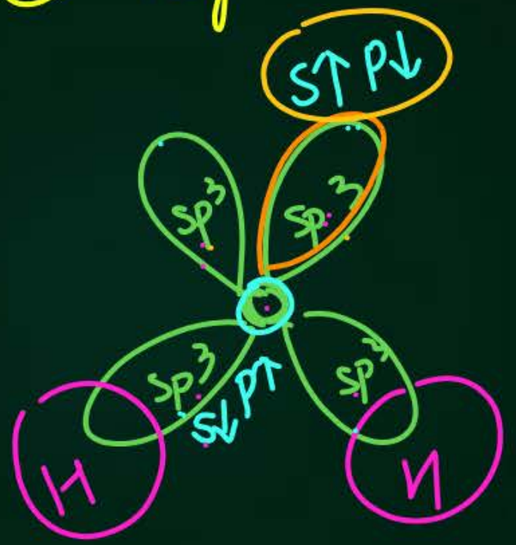
P—H bonds are formed by almost pure p orbitals.

Bent's Rule with MDJ

① l.p ko "s" pasand hai

② High EN ko "p" pasand hai.

$\theta < 109.5^\circ$



s %	p %	
25	75	sp^3
1/4	3/4	

1 : 3

s↑ θ↑
p↑ length↑

QUESTION

Which of the following attraction is strongest ?

1. Cl^- ..... H–Cl — I.D

2. $CHCl_3$ ..... $CHCl_3$ — D.D ✗

3. CCl_4 ..... H_2O — D.I.D ✗
   (NP) (P)

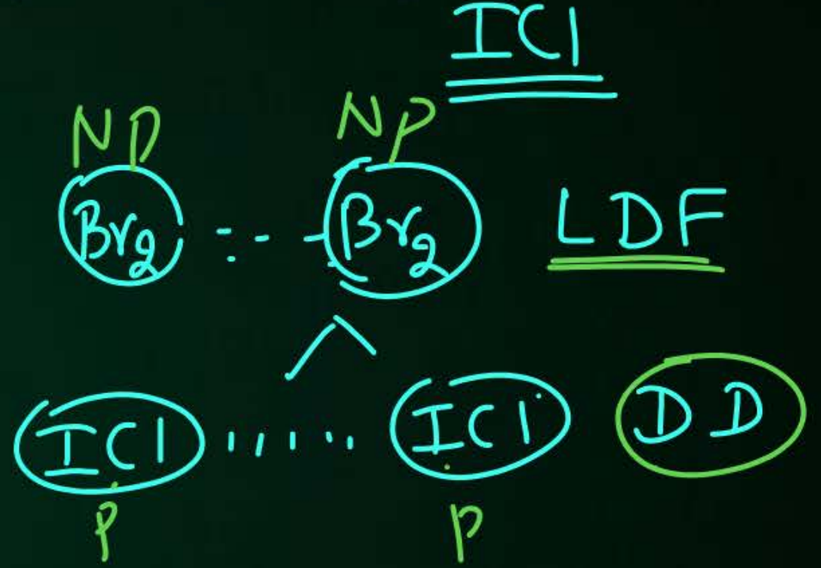
4. Cl^- ..... H_2O — I.D ✓

$H_2O > HCl$ Polarity (μ)

QUESTION

The molecular size of ICl and Br_2 is approximately same, but b.p. if Icl is about 40°C higher than that of Br_2. It is because :

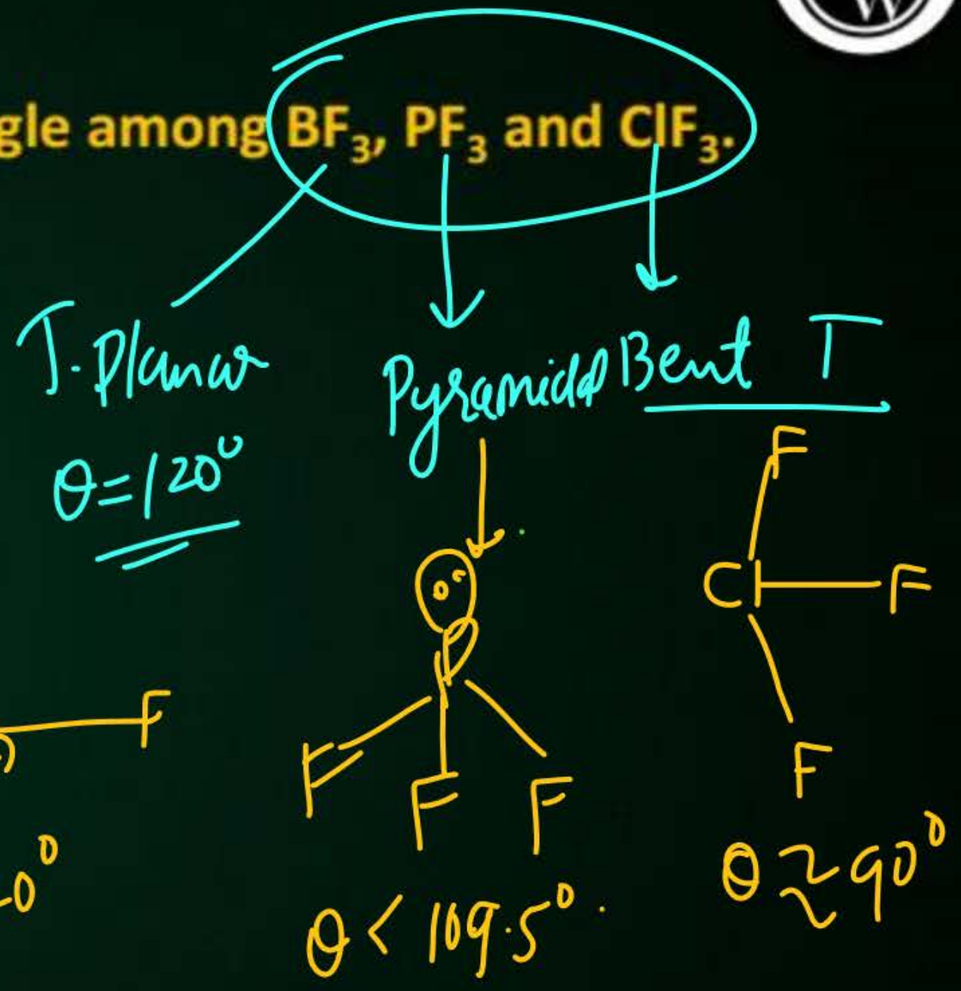
1. ICl bond is stronger than Br – Br bond
2. IE of iodine < IE of bromine
3. ICl is polar while Br_2 is nonpolar
4. I has larger size than Br



QUESTION

The correct increasing order of adjacent bond angle among BF_3, PF_3 and ClF_3.

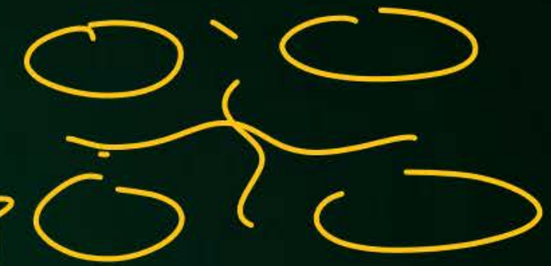
1. $BF_3 < PF_3 < ClF_3$
2. $PF_3 < BF_3 < ClF_3$
3. $ClF_3 < PF_3 < BF_3$
4. $BF_3 = PF_3 = ClF_3$



QUESTION

Low melting point is expected for a solid :

1. Ionic solid
2. Metallic solid
3. Molecular solid (Small Covalent Compounds)
4. Covalent solid (or Network solid diamond, graphite SiO_2 etc.) } giant covalent compounds.

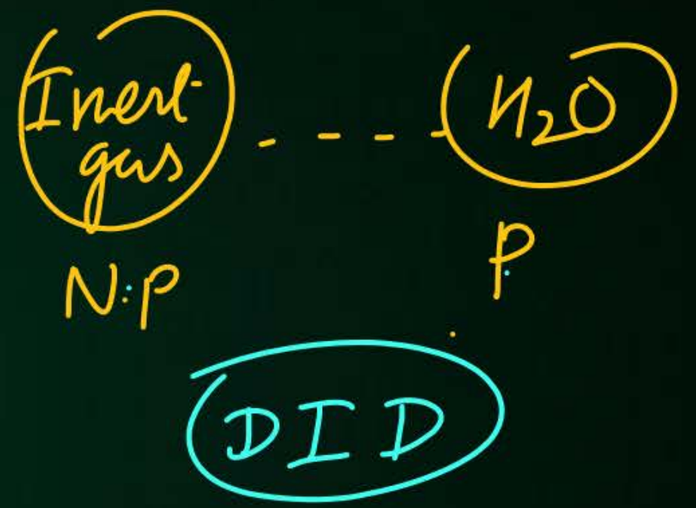


W.V.F forces b/w molecules

QUESTION

Solubility of inert gases increased as atomic number increases due to increase in

1. Dipole-dipole interaction
2. Dipole-induced dipole interaction
3. Induced dipole-instantaneous dipole interaction
4. Hydrogen bonding



QUESTION

Statement-1 : CCl_4 is a non-polar molecule.
Statement-2 : CCl_4 has polar bonds.

1. If statement-1 is true but the statement-2 is false.
2. If statement-1 is false but the statement-2 is true.
3. If both statements are true and the satemetn-2 is the correct explanation of statement-1.
4. If both statements are true and the satemetn-2 is not the correct explanation of statement-1.
5. Both statement are false.

QUESTION

A—13

Statement-1 : All diatomic molecules with polar bond have dipole moment.
Statement-2 : Dipole moment is a vector quantity.

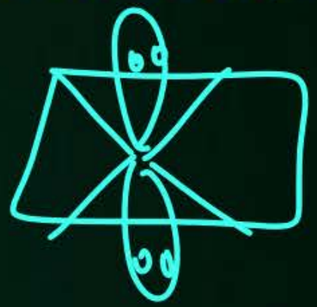
1. If statement-1 is true but the statement-2 is false.
2. If statement-1 is false but the statement-2 is true.
3. If both statements are true and the satemetn-2 is the correct explanation of statement-1.
4. If both statements are true and the satemetn-2 is not the correct explanation of statement-1.
5. Both statement are false.

QUESTION

AB_4L_2.

Statement-1 : The shape of XeF_4 is square-planar. ✓

Statement-2 : In an octahedral geometry, a single lone pair can occupy any position but a second lone pair will occupy position to the first lone pair.



1. If statement-1 is true but the statement-2 is false.
2. If statement-1 is false but the statement-2 is true.
3. If both statements are true and the satemetn-2 is the correct explanation of statement-1.
4. If both statements are true and the satemetn-2 is not the correct explanation of statement-1.
5. Both statement are false.

QUESTION

The correct statement with regards to H_2^+ and H_2^- is

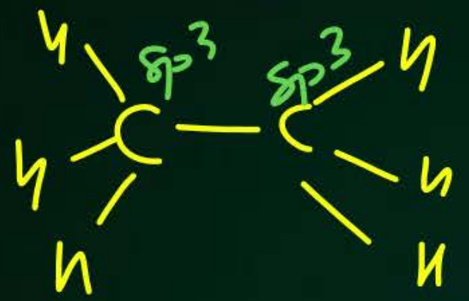
1. Both H_2^+ and H_2^- do not exist ✗
2. H_2^- is more stable than H_2^+ ✗
3. ✓ H_2^+ is more stable than H_2^-
4. Both H_2^+ and H_2^- are equally stable

If B.O is same

than stability $\propto \frac{1}{\text{ABMO } e^-}$

QUESTION

Which one of the following conversions involves change in both hybridization and shape ?



1. $CH_4 \rightarrow C_2H_6$ (sp^3 → sp^3)
2. $NH_3 \rightarrow NH_4^+$ (sp^3 → sp^3)
3. $BF_3 \rightarrow BF_4^-$ (sp^2 → sp^3, Tetra)
4. $H_2O \rightarrow H_3O^+$ (sp^3 → sp^3)

QUESTION

Which of the following substance has the highest melting point ?

1. $^{+2}Ba^{-2}O$
2. $^{+2}Mg^{-2}O$ ✓ — LET M.PT
3. $^{+1}K^{-1}Cl$ ✗
4. $^{+1}Na^{-1}Cl$ ✗

QUESTION

NH_3 has higher boiling point than expected because :

1. It forms NH_4OH with water
2. It has strong intermolecular hydrogen bonds
3. It has intermolecular hydrogen bonds
4. Its density decreases on freezing

H.W

QUESTION

MOT

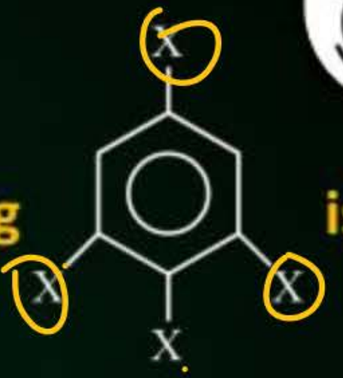
When O_2 is converted into O_2^+

$n=2$ $n=1$

1. Both paramagnetic character and bond order increase. ✗
2. Bond order decreases ✗
3. Paramagnetic character increases ✗
4. Paramagnetic character decreases and the bond order increses. ✓ ✓

QUESTION

Dipole moment of

is 1.5 D. The dipole moment of the following 

is :

1. 1.5 D
2. 2.35 D
3. 1 D
4. 3 D

QUESTION

Decreasing order of the hydrogen bonding in following forms of water is correctly represented by

A. Liquid water B. Ice C. Impure water

Choose the correct answer from the options given below: [JEE Main-2023]

1. A = B > C
2. A > B > C
3. C > B > A
4. B > A > C

QUESTION

The bond dissociation energy is higher for

[JEE Main-2023]

1. Br_2
2. F_2
3. Cl_2
4. I_2

$Cl_2 > Br_2 > F_2 > I_2$

F_2 → l.p - l.p repulsion

QUESTION

The correct order of hydration enthalpies is

(A) K^+ (B) Rb^+ (C) Mg^{2+} (D) Cs^+ (E) Ca^{2+}

Choose the correct answer from the options given below: [JEE Main-2023]

1. C > E > A > D > B

2. C > E > A > B > D

3. C > A > E > B > D

4. E > C > A > B > D

$Mg^{2+} > Ca^{2+} > K^+ > Rb^+ > Cs^+$

QUESTION

For OF_2 molecule consider the following:

A. Number of lone pairs on oxygen is 2.

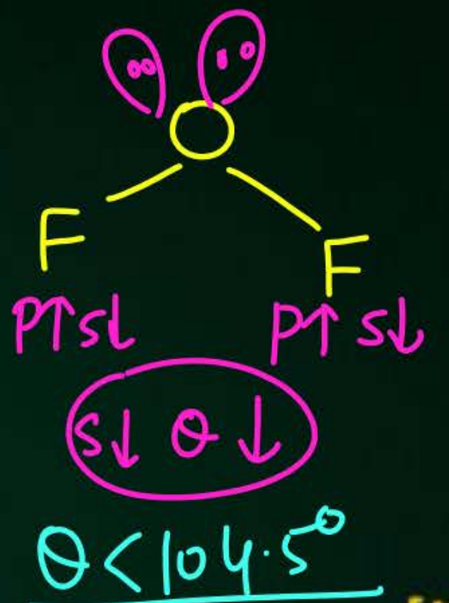
B. FOF angle is less than 104.5°.

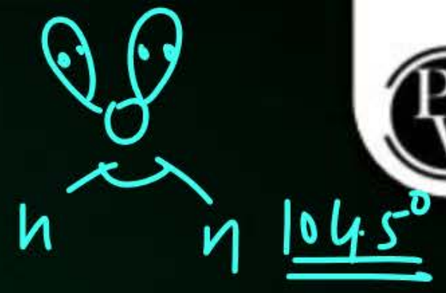
C. Oxidation state of O is –2.

D. Molecule is bent 'V' shaped.

E. Molecular geometry is linear.

Correct options are:





F High EN
"P" Pasand
Nai

[JEE Main-2023]

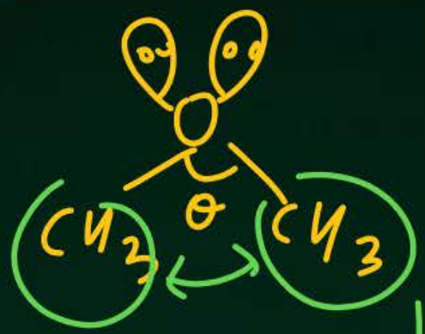
$OF_2 < H_2O$

0

1. A, B, D only
2. B, E, A only
3. A, C, D only
4. C, D, E only

Some Data based but Imp Ex.

$O(CH_3)_2$



$\theta < 109.5^\circ$

Large group more repulsion

$\theta \approx 119^\circ$

$OF_2 < H_2O$

$\theta < 104.5^\circ \quad \theta = 104.5$

QUESTION

Match List-I with List-II

List-I	List-II
A. XeF_4	I See saw
B. SF_4	II. Square planar
C. NH_4^+	III. Bent T-shaped
D. BrF_3	IV. Tetrahedral

H.W

Choose the correct answer from the options given below: [JEE Main-2023]

1. A-II, B-I, C-III, D-IV
2. A-IV, B-I, C-II, D-III
3. A-IV, B-III, C-II, D-I
4. A-II, B-I, C-IV, D-III

QUESTION

The correct order of bond enthalpy (kJ mol^{-1}) is :

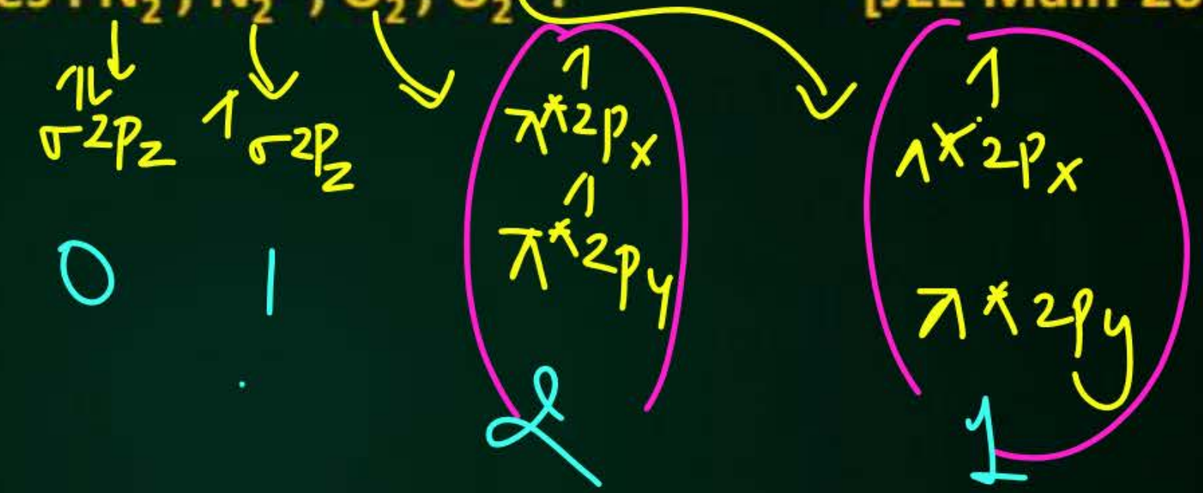
[JEE Main-2023]

1. C–C > Si–Si > Sn–Sn > Ge–Ge
2. Si–Si > C–C > Sn–Sn > Ge–Ge
3. C–C > Si–Si > Ge–Ge > Sn–Sn
4. Si–Si > C–C > Ge–Ge > Sn–Sn

H.W

QUESTION

What is the number of unpaired electron(s) in the highest occupied molecular orbital of the following species : N_2 ; N_2^+ ; O_2 ; O_2^+ ? [JEE Main-2023]

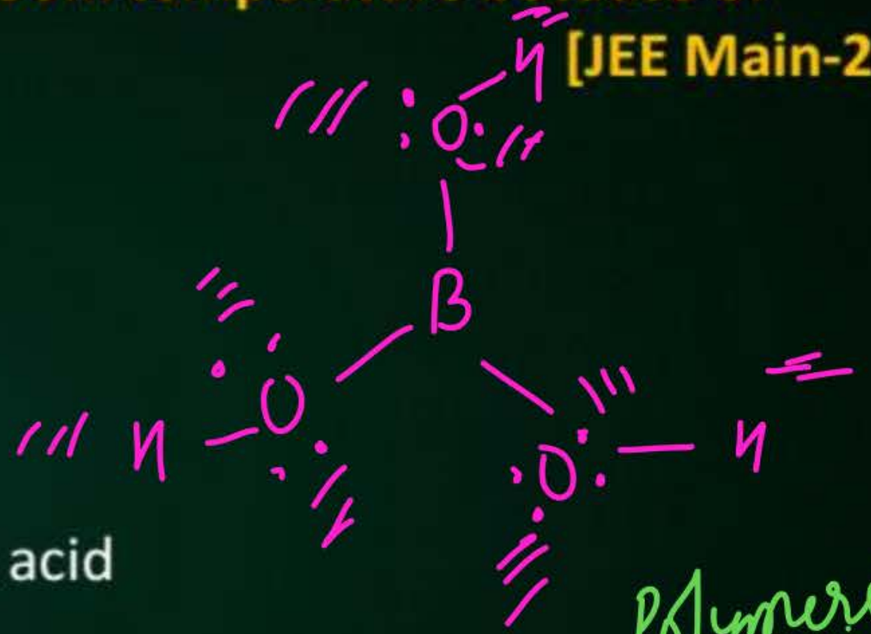


1. 0, 1 ,2, 1
2. 0, 1, 0, 1
3. 2, 1, 0, 1
4. 2, 1, 2, 1

QUESTION

Boric acid is solid, whereas BF_3 is gas at room temperature because of [JEE Main-2023]

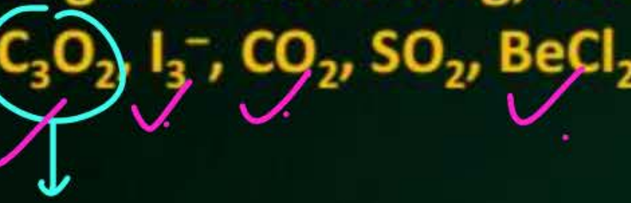
1. Strong covalent bond in BF_3
2. Strong ionic bond in Boric acid
3. Strong van der Waal's interaction in Boric acid
4. Strong hydrogen bond in Boric acid ✓



Polymeric in solid due to H-Bonding

QUESTION

Amongst the following, the number of species having the linear shape is XeF_2, I_3^+, C_3O_2, I_3^-, CO_2, SO_2, $BeCl_2$ and $BCl_2^{\ominus}$. [JEE Main-2023]



QUESTION

In which of the following pairs of molecules/ions, the central atoms have sp^2 hybridization? [AIPMT PRE-2010]

H.W

1. BF_3 and NH_2^-
2. NO_2^- and NH_3
3. BF_3 and NO_2^-
4. NH_2^- and H_2O

QUESTION

The maximum number of 90º angles between bond pair-bond pair of electrons is observed in : [AIEEE- 2004]

1. sp^3 hybridisation

H.W

2. sp^3d^2 hybridisation

3. sp^2 hybridisation

4. sp^3d hybridisation

QUESTION

In which of the following molecules/ions, all the bonds are not equal ?

[AIEEE- 2006]

1. SF_4 AB_4L_1 axial > eq.
2. SiF_4 AB_4L_0
3. XeF_4 AB_4L_2 a = e
4. BF_4^- AB_4L_0

QUESTION

Which of the following molecules/ions does not contain unpaired electrons?

[AIEEE- 2006]

H.W

1. O_2^{2-}
2. B_2
3. N_2^+
4. O_2

QUESTION

What is the dominant intermolecular force or bond that must be overcome in converting liquid CH_3OH to a gas ? **[AIPMT - 2009]**

1. London dispersion force
2. Hydrogen bonding
3. Dipole-dipole interaction
4. Covalent bonds

$CH_3OH \cdots CH_3OH$

(H-Bonding)

QUESTION

Which of the following is least likely to behave as Lewis base?

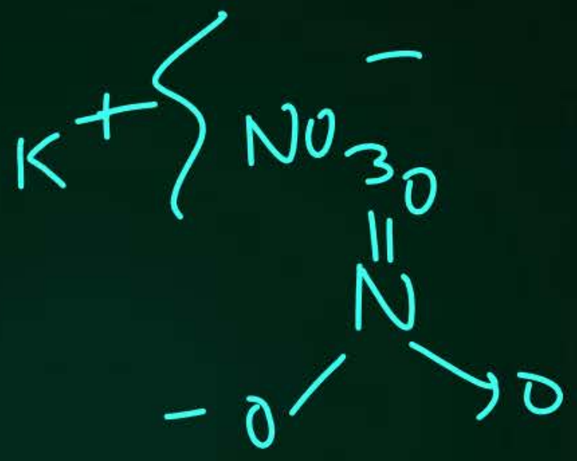
[AIPMT PRE-2011]

1. H_2O
2. NH_3
3. BF_3 (L.A)
4. OH^-

QUESTION

Which of the following compound contains(s) no covalent bonds(s) ?

KCl, PH_3, O_2, B_2H_6, H_2SO_4, KNO_3 [JEE Main - 2018]



1. KCl, B_2H_6, PH_3
2. KCl, H_2SO_4
3. KCl, KNO_3
4. KCl

QUESTION

According to molecular orbital theory, which of the following will not be a viable molecule : [JEE Main - 2018]

1. He_2^{2+}
2. He_2^{+}
3. H_2^{-}
4. H_2^{2-}

Hint

B.O = zero

H.W

QUESTION

The intermolecular interaction that is dependent on the inverse cube of distance between the molecules is : **[JEE Main - 2015]**

1. Ion-ion interaction
2. Ion-dipole interaction
3. London force
4. Hydrogen bond

$F \propto \frac{1}{r^3}$

H.W

QUESTION

The molecule having smallest bond angle is :

[AIEEE - 2012]

1. NCl_3
2. $AsCl_3$
3. $SbCl_3$
4. PCl_3

C.A ↑ O.L

H.W

QUESTION

Which one of the following species does not exist under normal conditions ?

[AIPMT PRE-2010]

1. Li_2
2. Be_2^+
3. Be_2
4. B_2

Hint

B.O = 0

H.W

QUESTION

In which of the following molecules the central atom does not have sp^3 hybridization : [AIPMT MAINS-2010]

1. SF_4
2. BF_4^-
3. NH_4^+
4. CH_4

H.W

QUESTION

Which one of the following elements is unable to form MF_6^{3-} ion ?

[NEET- 2018]

1. Ga
2. Al
3. B
4. In

H.W

QUESTION

An ether is more volatile than an alcohol having the same molecular formula. This is due to : **[AIEEE - 2003]**

1. dipolar character of ethers

2. alcohols having resonance structures

3. inter-molecular hydrogen bonding in ethers

4. inter-molecular hydrogen bonding in alcohols

QUESTION

Which one of the following compounds has the smallest bond angle in its molecule ? [AIEEE - 2003]

1. SO_2.
2. OH_2 H_2O
3. SH_2 H_2S ✓
4. NH_3

QUESTION

Which one of the following pairs of molecules will have permanent dipole moments for both members ? [AIEEE - 2003]

1. SiF_4 and NO_2

2. NO_2 and CO_2

3. NO_2 and O_3

4. SiF_4 and CO_2

QUESTION

Which one of the following statement about water is false ?

[JEE Main - 2016]

1. Water can act both as acid and as a base

$H_2O + NH_3$ (Acid.)

$H_2O + H_2S$ (Base)

2. There is extensive intramolecular hydrogen bonding in the condensed phase

3. Ice formed by heavy water sinks in normal water

4. None of these

QUESTION

The correct statement for the molecule, CsI_3 is

[JEE Main - 2014]

H.W

1. It is covalent molecule
2. It contains Cs^+ and I_3^-
3. It contains Cs^{3+} and I^- ions
4. It contains Cs^+, I^- and lattice I_2 molecule

QUESTION

Which one has the highest boiling point ?

[JEE Main - 2015]

1. He
2. Ne
3. Kr
4. Xe

H.W

QUESTION

Which of the following order is not correct ?

1, 3

1. $NaCl > MgCl_2 > AlCl_3$ (Covalent character)
2. $PO_4^{3-} > CO_3^{2-} > SO_4^{2-}$ (Formal change on terminal oxygen)
3. $N - N > P - P$ (Single bond strength)
4. $2p - 2p > 2s - 2p > 2s - 2s$ (Bond strength)

QUESTION

Find out the correct order of Dipole moment :

1. $SO_2 = CO_2$
2. $BF_3 = BeCl_2 = XeF_2$
3. $H_2O < H_2S$
4. $NH_3 < NF_3$

H.W

QUESTION

In which one of the following species the central atom has the type of hybridisation which is not the same as that present in the other three ?

[AIPMT PRE-2010]

1. PCl_5
2. SF_4
3. I_3^-
4. $SbCl_5^{2-}$

QUESTION

Which of the following is a polar molecule ?

[NEET(UG)-2013]

1. XeF_4
2. BF_3
3. SF_4
4. SiF_4

QUESTION

Which of the following hydrogen bonds is the strongest ?

[JEE Main- 2007]

1. O–H.....N
2. F–H.....F
3. O–H.....O
4. O–H.....F

QUESTION

The correct order of C–O bond length among CO, CO_3^{2-}, CO_2 is :

[AIPMT - 2007]

1. $CO < CO_2 < CO_3^{2-}$
2. $CO_2 < CO_3^{2-} < CO$
3. $CO < CO_3^{2-} < CO_2$
4. $CO_3^{2-} < CO_2 < CO$

H.W

QUESTION

H.W

The electronegativity difference between N and F is greater than that between N and H yet the dipole moment of NH_3 (1.5 D) is larger than that of NF_3 (0.2 D). This is because :

1. In NH_3 the atomic dipole and bond dipole are in the opposite directions whereas in NF_3 these are in the same direction

2. In NH_3 as well as in NF_3 the atomic dipole and bond dipole are in the same direction

3. In NH_3 the atomic dipole and bond dipole are in the same direction whereas in NF_3 these are in opposite directions

4. in NH_3 as well as NF_3 the atomic dipole and bond dipole are in opposite directions

QUESTION

In which of the following processes, the value of magnetic moment does not changes ?

1. $N_2 \longrightarrow N_2^{-2}$

   $n=0$ $\quad$ $n=2$

2. $B_2 \longrightarrow B_2^{-2}$

   $n=0$ $\quad$ $n=0$

3. $O_2^{+} \longrightarrow O_2^{-}$

   $n=1$ $\quad$ $n=1$

4. $O_2^{-} \longrightarrow O_2^{-2}$

   $n=1$ $\quad$ $n=0$

QUESTION

No change in π bonds order in reaction :

1. $N_2 \longrightarrow N_2^-$
2. $B_2 \longrightarrow B_2^-$
3. $O_2^{-2} \longrightarrow O_2^-$
4. $C_2 \longrightarrow C_2^{-2}$

$2\pi \quad 2\pi + 1\sigma$

C_2^{2-}

1ν
$\pi 2p_x$
1ν
$\pi 2p_y$
2π

1ν
$\sigma 2p_z$
1σ

$+$

QUESTION

Formal change on nitrogen and oxygen in NO_3^- ion are respectively :

1. $0, \frac{-1}{3}$
2. $+1, \frac{-2}{3}$
3. $+1, \frac{-1}{3}$
4. $0, \frac{-2}{3}$

H.W

QUESTION

According to molecule orbital theory which of the following is correct ?

1. LUMO level for C_2 molecule is a $\sigma 2p$ orbital

2. In C_2 molecule both the bonds are π bonds

3. In C_2^{2-} ion there is one σ and two π bonds

4. All the above are correct

QUESTION

For which of the following molecule significant $\mu \neq 0$?

H.W

1. Only (c)
2. (c) And (d)
3. Only (a)
4. (a) and (b)

(a)

(b)

(c)

(d)

QUESTION

The molecule which possesses both sp^3 and sp^3d^2 hybridisation is :

H.W

1. solid PCl_5
2. gaseous PCl_5
3. solid PBr_5
4. gaseous PBr_5

QUESTION

In which of the following s-p mixing is not operative :

1221

1. N_2
2. C_2
3. O_2
4. B_2

QUESTION

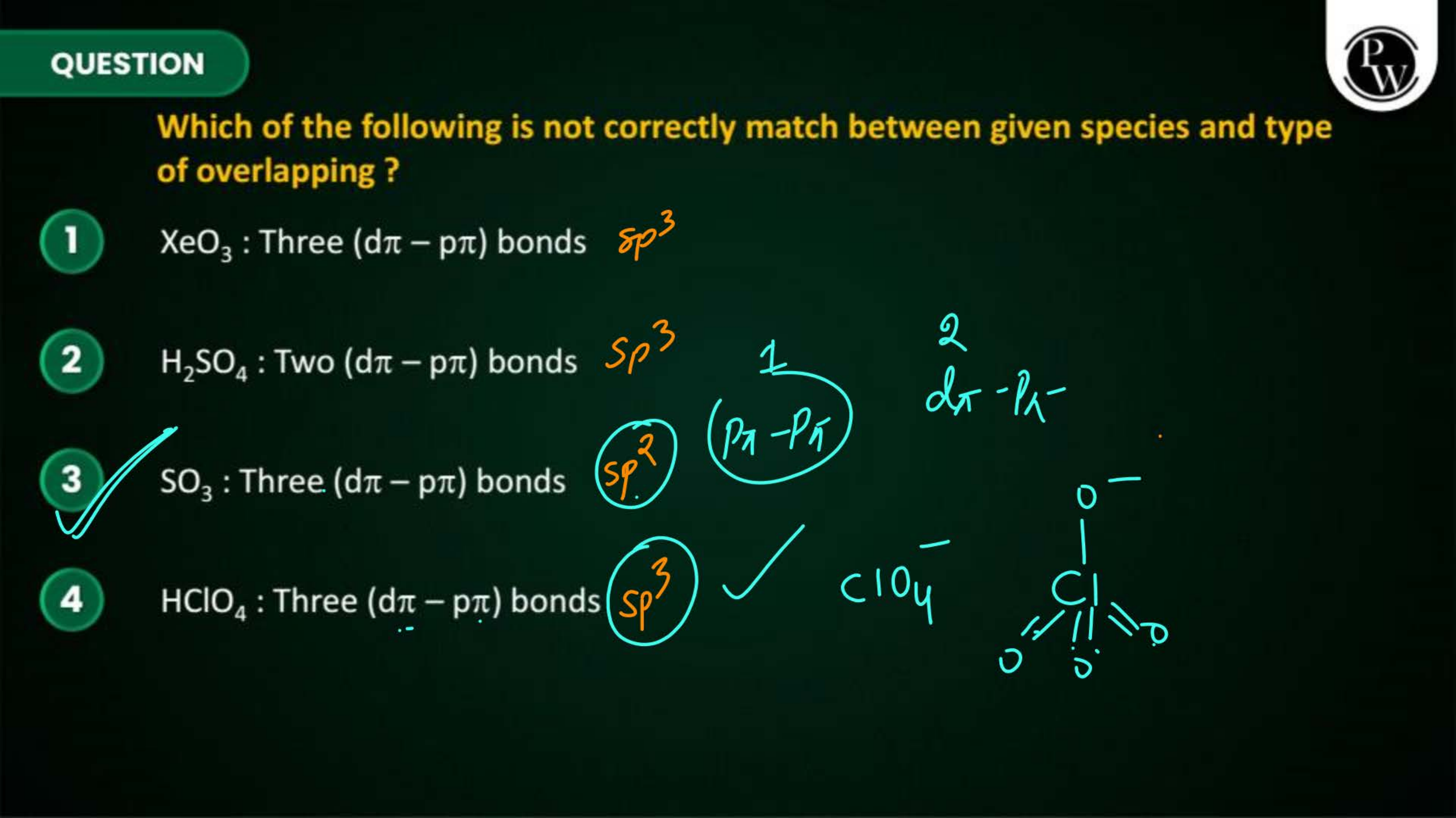
Which of the following is not correctly match between given species and type of overlapping ?

1. XeO_3 : Three ($d\pi - p\pi$) bonds

2. H_2SO_4 : Two ($d\pi - p\pi$) bonds

3. SO_3 : Three ($d\pi - p\pi$) bonds

4. $HClO_4$: Three ($d\pi - p\pi$) bonds



QUESTION

The pairs of species of oxygen and their magnetic behaviours are noted below. Which of the following presents the correct description ?

1. O_2, O_2^{2-} - Both paramagnetic

2. O_2^-, O_2^{2-} - Both diamagnetic

3. O_2^+, O_2^{2-} - Both paramagnetic

4. O_2^+, O_2 - Both paramagnetic

QUESTION

Which of the following statement is incorrect ?

1. Dipole moment of CH_3Cl is greater than CH_3F
2. ICl_2^- has a linear shape
3. XeF_2 has two lone pair of electrons
4. SF_2 is non linear molecule

H.W

QUESTION

In which of the following pairs, the hybridisation of central atoms is same, but molecular geometry is not the same ?

1. SO_3, CO_3^{2-}

2. SO_3^{2-}, NH_3

3. PCl_5, $POCl_3$

4. XeF_2, ICl_3

H.W

QUESTION

Intermolecular H-bonding is present :

1. H_2O
2. p-nitrophenol
3. H_3BO_3(solid)
4. All of these

QUESTION

What is the hybridisation state of central atom and shape in conjugate base of ammonium ion :

1. sp^3, trigonal planer
2. sp^2, trigonal planer
3. sp^3, pyramidal
4. sp^3d, T-shape

$NH_4^+ \xrightarrow{-H^+}$ NH_3

sp^3

QUESTION

Which intermolecular force is most responsible for liquefaction of inert gas ?

1. Ionic
2. Instantaneous dipole – induced dipole
3. Dipole – dipole
4. Ion – dipole

Ne - Ne
LDF

QUESTION

Correct match is/are :

	Compound		Hybridisation/shape
1	$SiCl_4$	:	See-Saw
2	SF_4	:	sp^3
3	H_3O^+	:	Pyramidal
4	All of these		

H.W

QUESTION

Which of the following pair cannot exhibit covalency more than four ?

1. P, S
2. B, N
3. Cl, Si
4. None of these

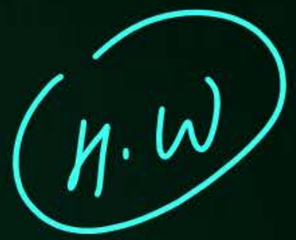
H.W

QUESTION

Out of given species how many are contains σ coordinate bond

PCl_6^- , PCl_5, PH_4^+, NH_4Cl, NH_4^+, BF_3, NO_3^-

1. 2
2. 5
3. 4
4. 3



QUESTION

Correct statement about NO_2

1. $O - \hat{N} - O$ bond angle is $< 120°$
2. Hybridisation of N is sp
3. It is a brown coloured gas and diamagnetic
4. None of these

QUESTION

Which of the following species is not stable ?

1. $[SiF_6]^{2-}$
2. $[GeCl_6]^{2-}$
3. $[Sn(OH)_6]^{2-}$
4. $[SiCl_6]^{2-}$

1 Votes

QUESTION

Select correct statement about CH_4

1. All the hybrid orbitals of carbon are equivalent
2. All the hybrid orbitals of carbon have 25% 2s property
3. All the hybrid orbitals of carbon are projected at the four vertex of a regular tetrahedron
4. All are correct statements

QUESTION

According to VBT, which of the following overlapping results π-type covalent bond in O_2 molecule formation, when Z-axis is internuclear axis ?

(I) 2s-2s

(II) $2p_x - 2p_x$

(III) 1s-1s

(IV) $2p_y - 2p_y$

(V) $2p_z - 2p_z$

1. I, III
2. II, V
3. II, IV
4. IV, V

QUESTION

Correct order of lattice energy is

1. $K_2O < Rb_2O$
2. $NaF < KF$
3. $NaF < MgO$
4. $Al_2O_3 < MgO$

H.W

QUESTION

Find the correct order of covalent character in following :

1. $NaCl > MgCl_2$
2. $AgCl < AgF$
3. $NaCl > ZnCl_2$
4. $CaCl_2 < CdCl_2$

QUESTION

Lone pair having maximum directional nature present in :

1. BiH_3
2. SbH_3
3. NH_3
4. PH_3

NOTES

QUESTION

The pair of elements which on combination are most likely to form an ionic compound is :

1. Na and Ca
2. K and O_2
3. O_2 and Cl_2
4. Al and I_2

AlI_3 Fajan's Conv.

QUESTION

PCl_5 exists but NCl_5 does not because :

1. Nitrogen has no vacant d-orbitals

H.W

2. NCl_5 is unstable

3. Nitrogen atom is much smaller than P

4. Nitrogen is highly inert

QUESTION

Dative bond is present in :

1. O_3
2. NH_3
3. $BaCl_2$
4. BF_3

H.W

QUESTION

Select the correct relation.

1. $\mu\ NH_3 = \mu\ NF_3$
2. $\mu\ NH_3 > \mu\ NF_3$
3. $\mu\ NH_3 < \mu\ NF_3$
4. $\mu\ NH_3 >< \mu\ NF_3$

QUESTION

The correct order of decreasing polarizability of ion is :

1. $Cl^- > Br^- > I^- > F^-$
2. $F^- > I^- > Br^- > Cl^-$
3. $I^- > Br^- > Cl^- > F^-$
4. $F^- > Cl^- > Br^- > I^-$

H.W

QUESTION

Which p-orbitals overlapping would give the strongest bond ?

1

2

3

4

QUESTION

Which one of the following is paramagnetic and has bond order 1/2 ?

1. H_2
2. H_2^+
3. N_2
4. F_2

H.W

QUESTION

The shape of covalent molecule MX_3 is :

AB_3 → AB_3L_0 Planar
AB_3L_2 Bent T
AB_3L_1 Pyramidal

1. Triangular
2. T-shape
3. pyramidal
4. Either of these depending on number of lone pairs of electron on M

QUESTION

Which molecule is T-shaped ?

1. BeF_2
2. BCl_3
3. NH_3
4. ClF_3

QUESTION

Which shows a change in the type of hybridisation when

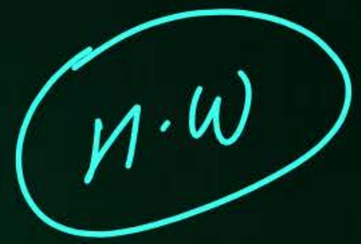
1. NH_3 combines with H^+
2. BF_3 combines with F^-
3. In both cases
4. In none of these cases

H.W

QUESTION

The species which does not show paramagnetic is :

1. O_2
2. O_2^+
3. O_2^{2-}
4. H_2^+



QUESTION

The correct increasing bond angles order is :

1. $BF_3 < NF_3 < PF_3 > ClF_3$

2. $ClF_3 > PF_3 < NF_3 < BF_3$

3. $BF_3 \approx NF_3 < PF_3 < ClF_3$

4. $BF_3 < NF_3 < PF_3 < ClF_3$

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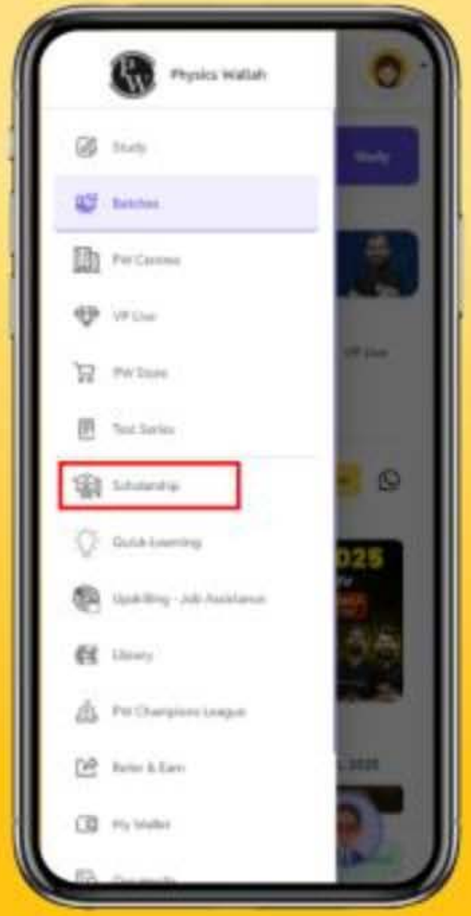

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Cohort	Class	Name of the Test	Exam Date	Mode	Physics	Chemistry	Botany	Zoology
NEET	11	Test 1	13-Oct-2024	Online	Basic Maths & Calculus (Mathematical Tools) Vectors Units and Measurements Motion in a straight line	Structure of Atom Some Basic Concepts of Chemistry Classification of Elements and Periodicity in Properties	Cell - The Unit of Life Cell Cycle and Cell Division	Structural Organization in Animals Breathing and Exchange of Gases

12th NEET REAL TEST SERIES SYLLABUS

Cohort	Class	Name of the Test	Exam Date	Mode	Physics	Chemistry	Botany	Zoology
NEET	12	Test 1	13-Oct-2024	Online	Electric Charges and Fields Electrostatic Potential and Capacitance	Solution Electrochemistry	Sexual Reproduction in Flowering Plant	Human Reproduction

DROPPER NEET REAL TEST SERIES SYLLABUS

Cohort	Class	Name of the Test	Exam Date	Mode	Physics	Chemistry	Botany	Zoology
NEET	Dropper	Test 1	13-Oct-2024	Online	Basic Maths & Calculus (Mathematical Tools) Vectors Units and Measurements Motion in a straight line Motion in a plane Circular motion Laws of motion	Some Basic Concept of Chemistry Redox Reaction Solutions Thermodynamics Equilibrium Electrochemistry	Cell - The Unit of Life Cell Cycle and Cell Division The Living World Biological Classification Plant Kingdom Morphology of Flowering Plants	Structural Organization in Animals Breathing and Exchange of Gases Body Fluids and Circulation Excretory Products & their Elimination

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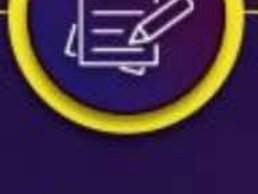

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THANK YOU

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FOR NEET 2025

Lecture- 01 | Inorganic Chemistry

Classification of Elements and Periodicity in Properties

By - Mohit Dadheech (MD Sir)

Topics *to be covered*

1. Basics of Present format periodic table
2. Layout & mnemonics of periodic table.

Ha to Raja Aao shuru Karte Hai.....

#feel wali IOC

Recap :-

Quantum Numbers

(PQN) Principal Q.N $\Rightarrow$ n $\Rightarrow$ shell no. 1, 2, 3, 4 . . . .

AQN $\rightarrow$ ℓ $\Rightarrow$ subshell s, p, d, f . . .
(0, 1, 2, 3)

$[\ell = 0 \text{ to } n-1]$

3s

shell no. (n)

$n = 3$
$\ell = 0$

$(n+\ell)$ Rule

$n = 3$

$l = ?$

shell

$l = 0$ to $n-1$

0, 1, 2

s p d

3s, 3p, 3d ✓

Subshells

$n = 4$

$l = 0, 1, 2, 3$

s p d f

(n) 3rd shell → subshells ?

(n) 3rd period → subshells 6

Basics of long form of Periodic Table :

Modern Periodic Law :

"The physical & chemical properties of elements are periodic functions of their atomic number (Z)"

(Z) = 1 2 3 4

H He Li Be

$1e^-$ $2e^-$ $3e^-$ $4e^-$

1pt 2pt 3pt 4pt

(Z) = no. of Protons

Na $Z = 11$ $p^+ = 11$ $e^- = 11$

Na^+ $p^+ = 11$ $e^- = 10$

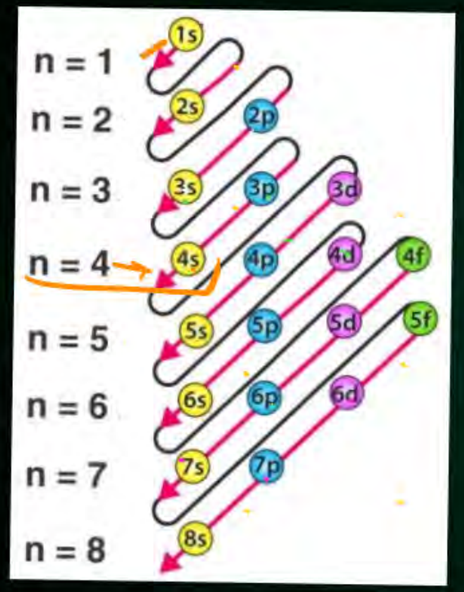
* In Periodic Table elements are arranged in order of Increasing atomic number

Thus each element Contains one more electron & proton than preceding element

Z →	1	2	3	4	5	. . . . .
	H	He	Li	Be	B	. . .
e^-	1	2	3	4	5	. . .
p^+	1	2	3	4	5	. . .

* 7 Horizontal lines → Periods (n)
(L → R)
denoted by "n"

* 18 Vertical Columns → Groups
(1 to 18)



For filling sequence.

(n+l) Rule

s p d f

7p ← 6d ← 5f ← 7s

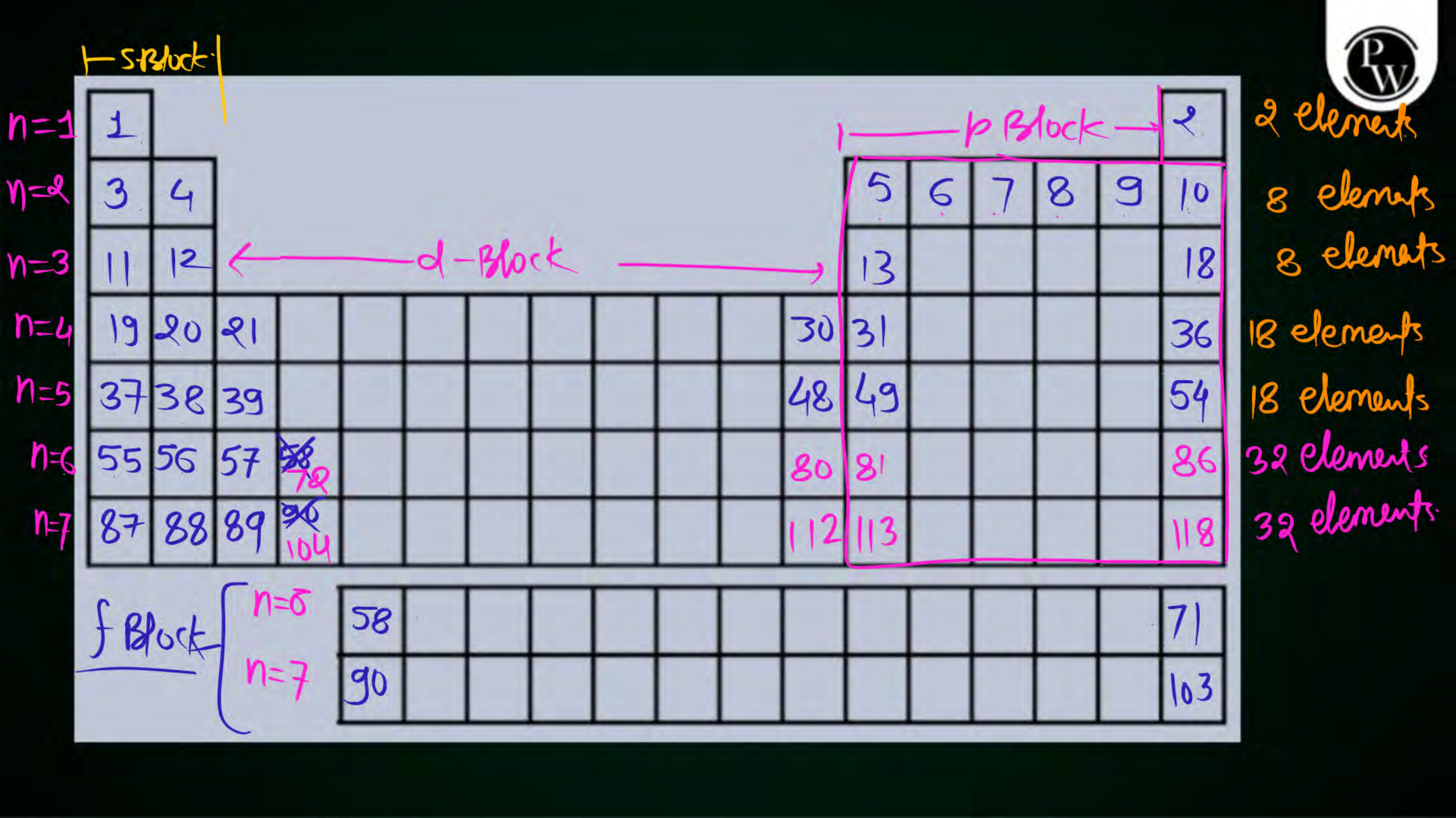
6e⁻ + 10e⁻ + 14e⁻ + 2e⁻

n=7

32e⁻

1s → 2s → 2p → 3s → 3p → 4s → 3d → 4p → 5s → 4d → 5p → 6s → 4f → 5d → 6p

n=1	n=2	n=3	n=4	n=5	n=6
2e⁻	2e⁻ + 6e⁻	2e⁻ + 6e⁻	2e⁻ + 10e⁻ + 6e⁻	2e⁻ + 10e⁻ + 6e⁻	2e⁻ + 14e⁻ + 10e⁻ + 6e⁻
	8e⁻	8e	18e⁻	18e⁻	32e⁻


s-Block
p Block
d-Block
f Block
n=1
n=2
n=3
n=4
n=5
n=6
n=7
1
2
3
4
11
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48
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54
55
56
57
72
80
81
86
87
88
89
104
112
113
118
58
71
90
103
n=6
n=7
2 elements
8 elements
8 elements
18 elements
18 elements
32 elements
32 elements

Formula of Periodic Table :

(n+l) Rule

$ns \to (n-2)f \to (n-1)d \to np$

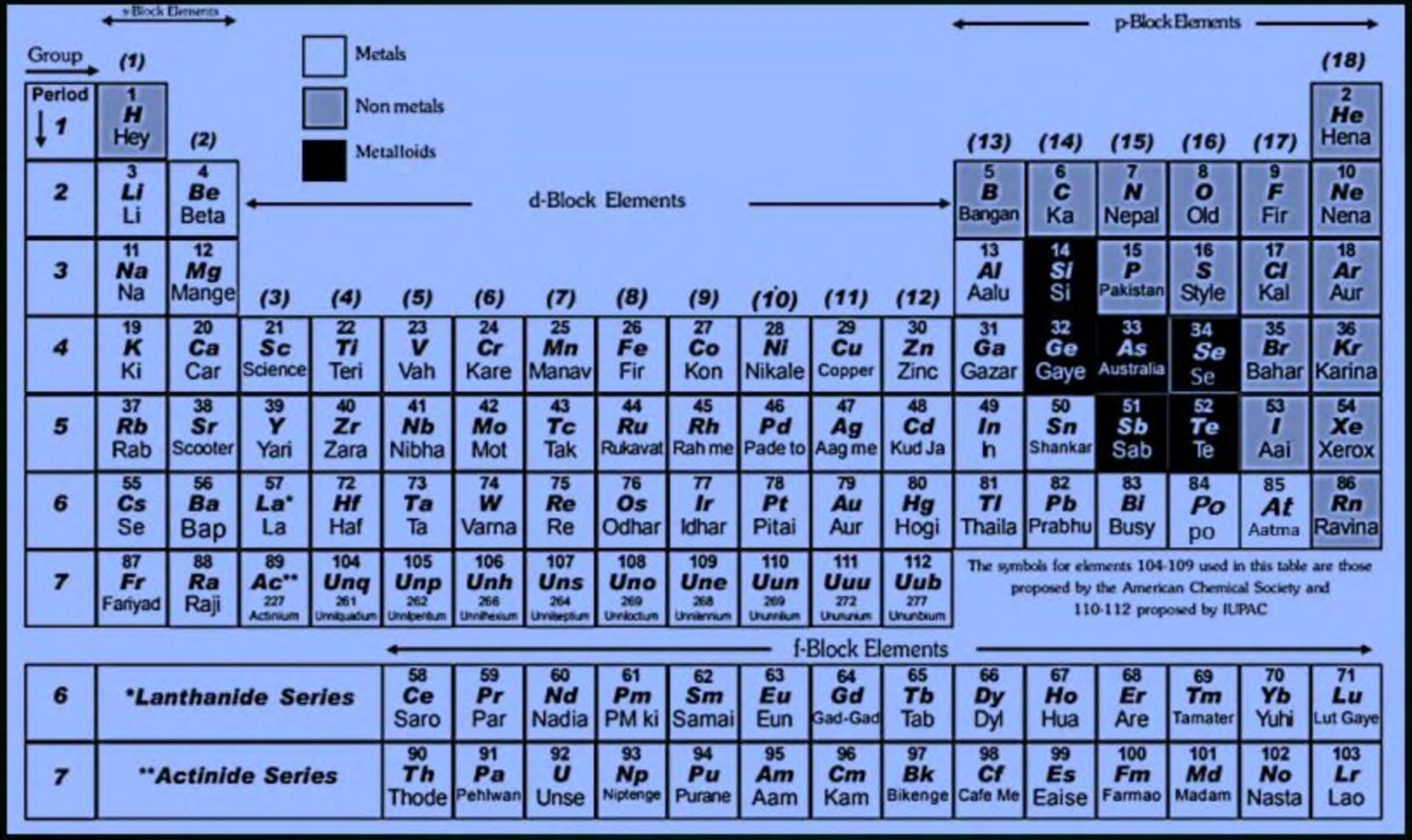
Formula

(n)	Period subshells	no. of elements
n=1	1s	2
n=2	2s ⟶ 2p	8
n=3	3s ⟶ 3p	8
n=4	4s → 3d → 4p	18
n=5	5s → 4d → 5p	18
n=6	6s → 4f → 5d → 6p	32
n=7	7s → 5f → 6d → 7p	32

6s → 4f → 5d → 6p
ns (n-2)f (n-1)d np

MDJ

s
sp
spd
spdf
spdf
spdf


s-Block Elements
p-Block Elements
Group
(1)
(18)
Metals
Non metals
Metalloids
Period
1 H Hey
2 He Hena
(2)
(13) (14) (15) (16) (17)
2 Li Li; Be Beta; B Bangan; C Ka; N Nepal; O Old; F Fir; Ne Nena
3 Na Na; Mg Mange; Al Aalu; Si Si; P Pakistan; S Style; Cl Kal; Ar Aur
d-Block Elements
(3) (4) (5) (6) (7) (8) (9) (10) (11) (12)
4 K Ki; Ca Car; Sc Science; Ti Teri; V Vah; Cr Kare; Mn Manav; Fe Fir; Co Kon; Ni Nikale; Cu Copper; Zn Zinc; Ga Gazar; Ge Gaye; As Australia; Se Se; Br Bahar; Kr Karina
5 Rb Rab; Sr Scooter; Y Yari; Zr Zara; Nb Nibha; Mo Mot; Tc Tak; Ru Rukavat; Rh Rah me; Pd Pade to; Ag Aag me; Cd Kud Ja; In In; Sn Shankar; Sb Sab; Te Te; I Aai; Xe Xerox
6 Cs Se; Ba Bap; La* La; Hf Haf; Ta Ta; W Varna; Re Re; Os Odhar; Ir Idhar; Pt Pitai; Au Aur; Hg Hogi; Tl Thaila; Pb Prabhu; Bi Busy; Po po; At Aatma; Rn Ravina
7 Fr Fariyad; Ra Raji; Ac** 227 Actinium; 104 Unq 261 Unnilquadium; 105 Unp 262 Unnilpentium; 106 Unh 266 Unnilhexium; 107 Uns 264 Unnilseptium; 108 Uno 269 Unniloctium; 109 Une 268 Unnilennium; 110 Uun 269 Ununnilium; 111 Uuu 272 Unununium; 112 Uub 277 Ununbium
The symbols for elements 104-109 used in this table are those proposed by the American Chemical Society and 110-112 proposed by IUPAC
f-Block Elements
6 *Lanthanide Series: 58 Ce Saro; 59 Pr Par; 60 Nd Nadia; 61 Pm PM ki; 62 Sm Samai; 63 Eu Eun; 64 Gd Gad-Gad; 65 Tb Tab; 66 Dy Dyl; 67 Ho Hua; 68 Er Are; 69 Tm Tamater; 70 Yb Yuhi; 71 Lu Lut Gaye
7 **Actinide Series: 90 Th Thode; 91 Pa Pehlwan; 92 U Unse; 93 Np Niptenge; 94 Pu Purane; 95 Am Aam; 96 Cm Kam; 97 Bk Bikenge; 98 Cf Cafe Me; 99 Es Eaise; 100 Fm Farmao; 101 Md Madam; 102 No Nasta; 103 Lr Lao

Trick

S & P

T → B

d & f → L → R

QUESTION

After the filling of np-orbitals next orbital filled will be:

n=5

5s → 4d → 5p

ns → (n-2)f → (n-1)d → (np)

6s → 4f → 5d → 6p

(n+1)s (n-1)f nd (n+1)p

w.r.t n=5

A ns ✗

B (n + 1)p ✓

C (n – 1)d ✗

D (n + 1)d ✗

QUESTION

In the fourth period of the periodic table, how many elements have one or more 4d electrons?

4s → 3d → 4p

4d

A 2

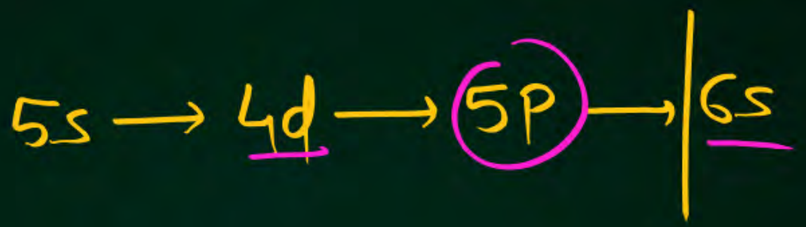
B 18

C 0

D 6

QUESTION

The subshell which are filled just before and just after the filling of 5p subshell are respectively:



A 5s, 5d

B 4d, 6s

C 4d, 4f

D 6s, 4f

QUESTION

If the principal quantum number n = 6, the correct sequence of filling of electrons will be:

A $ns \rightarrow (n-1)d \rightarrow (n-2)f \rightarrow np$

B $ns \rightarrow np \rightarrow (n-1)d \rightarrow (n-2)f$

C $ns \rightarrow (n-2)f \rightarrow (n-1)d \rightarrow np$

D $ns \rightarrow (n-2)f \rightarrow np \rightarrow (n-1)d$

QUESTION

The period number in the long form of the periodic table is equal to

A Magnetic quantum number of any element of the period.

B Atomic number of any element of the period.

C Maximum Principal quantum number of any element of the period.

D Maximum Azimuthal quantum number of any element of the period.

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FOR NEET 2025

Lecture- 02 | Inorganic Chemistry

Classification of Elements and Periodicity in Properties

By - Mohit Dadheech (MD Sir)

Topics *to be covered*

1. Basics of Present format periodic table
2. Electronic Configurations

Basics of Present format periodic table

- Groups
- Periods
- Blocks
- Formula of periodic table ✓
- Layout and mnemonics ✓

GROUPS

- 18 vertical Columns (1 to 18)
- Largest group of PT → 3rd → 32 Elements < 28 f Block, 4 d Block
- All f-Block Elements are placed in Same group (3rd group)
- gen Outermost ē configuration remains Same in elements belong to Same group

group No.	Block
1 - 2	s
3 - 12	d
13 - 18	p

group 1 Alkali metals Li, Na, K, Rb, Cs, NaOH, Na_2O } Basic

group 2 Alkaline earth metals Be, Mg - - -

group 3 to 12 d-Block, | 3rd group → 28 f-Block + 4 d Block

group 13 Boron family

14 Carbon Family

15 pnictogens

16 Chalcogens

17 Halogens

18 Inert gases

(n)	(Z)	Name
1	2	He
2	10	Ne
3	18	Ar
4	36	Kr
5	54	Xe
6	86	Rn
7	118	Og

PERIODS

↳ 7 Horizontal lines denoted by "n" (P.Q.N)

↳ Based on no. of elements present divided into.

shortest	short	long	longest
n=1	n=2,3	n=4,5	n=6,7
(2)	(8)	(18)	(32)

↳ Each Period starts with S-Block & End With p-Block element.
(Alkali Metal) (Noble gas)

↳ Lanthanoids & Actinoids are placed into 6th & 7th Periods Respectively

↳ No. of Elements in a given period "n"

(i) If "n" is odd no. $= \frac{(n+1)^2}{2}$ Ex $n=5$, $\frac{(5+1)^2}{2} = 18$

(ii) If "n" is even no. $= \frac{(n+2)^2}{2}$ Ex $n=6$, $\frac{(6+2)^2}{2} = 32$

↳

NCERT LIVE ***

Number of elements in each period is twice the number of atomic orbitals available in energy level that is being filled

Ex $n=2$ 2s 2p $4 \times 2 = 8$

BLOCKS

↳ Four Blocks s, p, d, f are present in PT

↳ Name of Blocks are given on the basis of Subshell in which Last e^- enters.

s-Block → Last e^- enters into "s" subshell

p-Block → Last e^- enters into p subshell (Except He $1s^2$)

d-Block → Last e^- enters into "d"

f-Block → —n—— into "f"

How to write Electronic Configuration of any Element except exceptions :

$n+l$

$ns \rightarrow (n-2)f \rightarrow (n-1)d \rightarrow np$

s
s p
s p
s d p
s d p
s f d p
s f d p

step-I

find period no. (n) of given (Z)

Z = 32

next inert gas = 36

n = 4

n of given Z = n of next inert gas

32 − 18 = 14

[Ar] $4s^2 \rightarrow 3d^{10} \rightarrow 4p^2$

Z = 18

step-2

[Pre. Inert gas] $ns \rightarrow (n-2)f \rightarrow (n-1)d \rightarrow np$

↓ according to Period no.

$Z = 80$

$n = ?$

$n = 6$

Next inert gas → 86

$n = 6$

Pre inert gas ⇒ (Xe) $Z = 54$

$$80 - 54 = 26\ e^-$$

$$[Xe]\ 6s^2 \rightarrow 4f^{14} \rightarrow 5d^{10} \rightarrow 6p^0$$

(or)

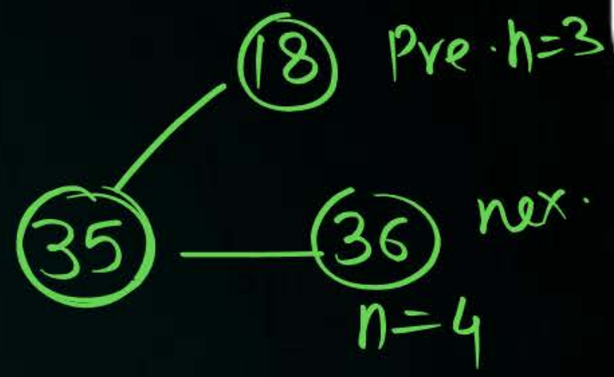
$$[Xe]\ 4f^{14}\ 5d^{10}\ 6s^2$$

$Z = 35$ $n = 4$

$35 - 18 = 17$

$(18)[Ar]\ 4s^2 \rightarrow 3d^{10} \rightarrow 4p^5$

$[Ar]\ 3d^{10}\ 4s^2\ 4p^5$



$Z = 51$

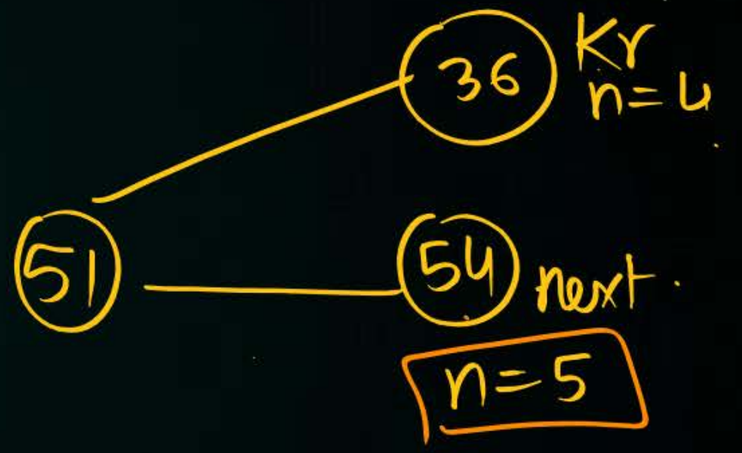
$n = 5$

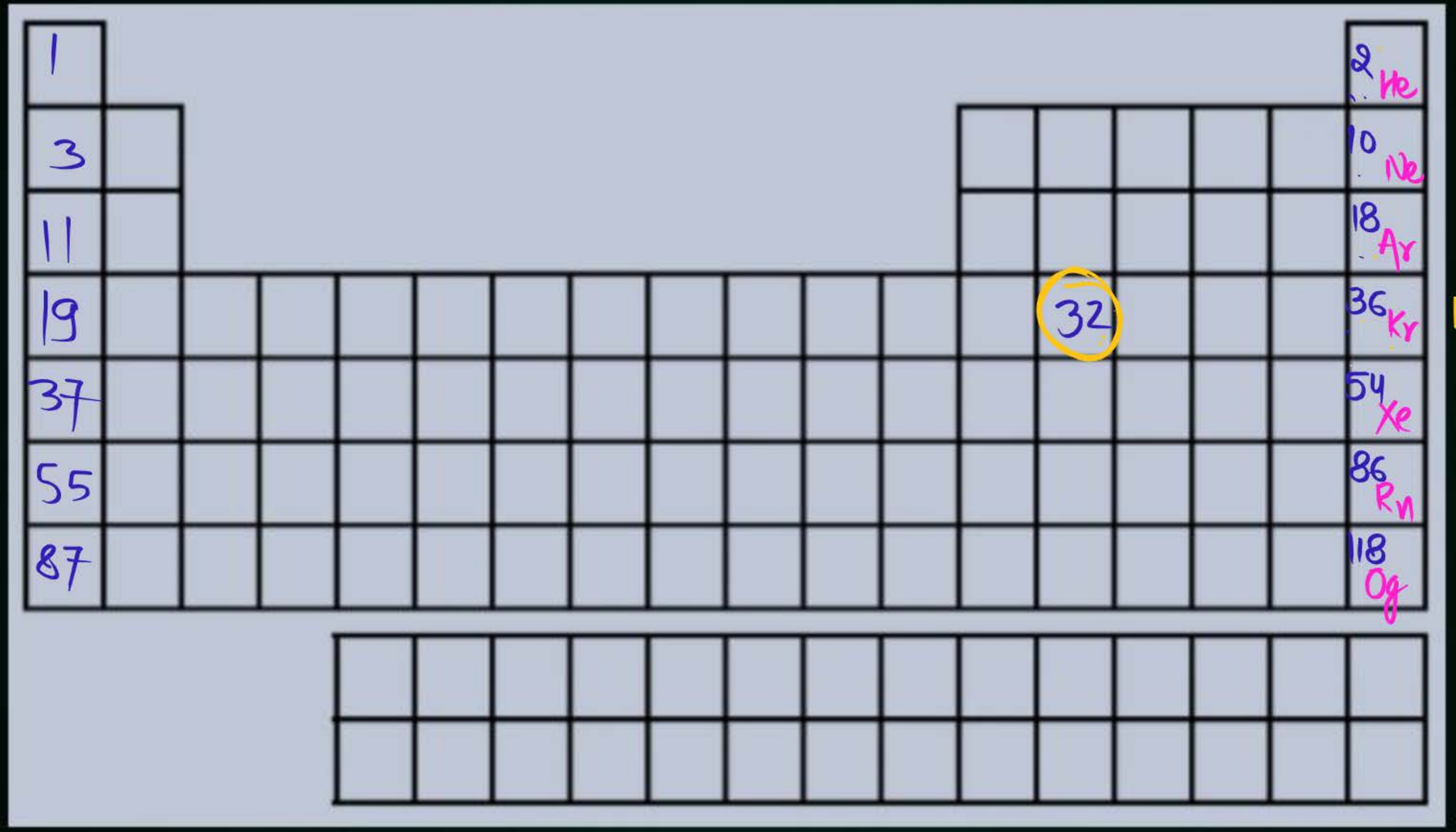
$51 - 36 = 15$

$(36)[Kr]\ 5s^2 \rightarrow 4d^{10} \rightarrow 5p^3$

or

$[Kr]\ 4d^{10}\ 5s^2\ 5p^3$




1
3
11
19
37
55
87
2 He
10 Ne
18 Ar
36 Kr
54 Xe
86 Rn
118 Og
32
n=4

Nomenclature of elements with Atomic Number Above 100 :

Digit	Name
0	Nil
1	Un
2	Bi
3	Tri
4	Quad
5	Pent
6	Hex
7	Sept
8	Oct
9	Enn

Suffix → ium

Ex z = 111

Un Un Un + ium

UnUnUnium (Uuu)

z = 105

Un nil Pent + ium.

Unnilpentium (Unp)

Atomic Number	Name according to IUPAC nomenclature	Symbol	IUPAC Official Name	IUPAC Symbol	TRICK
101	Unnilunium	Unu	Mendelevium	Md	Modi ka
102	Unnilbium	Unb	Nobelium	No	Number
103	Unniltrium	Unt	Lawrencium	Lr	Lahore ke
104	Unnilquadium	Unq	Rutherfordium	Rf	Refugee ne
105	Unnilpentium	Unp	Dubnium	Db	Dubai aur
106	Unnilhexium	Unh	Seaborgium	Sg	Singapore ke
107	Unnilseptium	Uns	Bohrium	Bh	Bahar diya
108	Unniloctium	Uno	Hassium	Hs	Hans
109	Unnilennium	Une	Meitnerium	Mt	Mat
110	Ununnilium	Uun	Darmstadtium	Ds	Dus
111	Unununnium	Uuu	Rontgenium	Rg	Rang ka
112	Ununbium	Uub	Copernicium	Cn	Konsa
113	Ununtrium	Uut	Nihonium	Nh	Nahi
114	Ununquadium	Uuq	Flerovium	Fl	Flower
115	Ununpentium	Uup	Moscovium	Mc	Mac
116	Ununhexium	Uuh	Livermorium	Lv	Lovers
117	Ununseptium	Uus	Tennessine	Ts	Tussi
118	Ununoctium	Uuo	Oganesson	Og	O god

Blockwise e^- Configurations

S-Block

gen outer e^- Configuration $\Rightarrow$ ns^{1-2}

group No. of S-Block = no. of ns e^-

n=	group-1	group-2
2	Li [He] $2s^1$	Be [He] $2s^2$
3	Na [Ne] $3s^1$	Mg [Ne] $3s^2$
4	K [Ar] $4s^1$	Ca [Ar] $4s^2$
5	Rb [Kr] $5s^1$	Sr [Kr] $5s^2$
6	Cs [Xe] $6s^1$	Ba [Xe] $6s^2$
7	Fr [Rn] $7s^1$	Ra [Rn] $7s^2$

ns^1 → Alkali Metals

ns^2 → Alkaline earth Metals

p-Block

gen outer e^- Configuration → $ns^2\ np^{1-6}$

Group	13 (ns^2np^1)	14 (ns^2np^2)	15 (ns^2np^3)	16 ns^2np^4	17 ns^2np^5	18 ns^2np^6
n=2	B [He] $2s^2\ 2p^1$					
3	Al [Ne] $3s^2\ 3p^1$					
4	Ga [Ar] $4s^2\ 3d^{10}\ 4p^1$					
5	In [Kr] $5s^2\ 4d^{10}\ 5p^1$					
6	Tl [Xe] $6s^2\ 4f^{14}\ 5d^{10}\ 6p^1$					

H.W

NCERT KI CHOTI CHOTI MAGAR MOTI BAATEIN

- Atomic number is equal to the nuclear charge (i.e., number of protons) or the number of electrons in a neutral atom. It is then easy to visualize the significance of quantum numbers and electronic configurations in periodicity of elements. In fact, it is now recognized that the Periodic Law is essentially the consequence of the periodic variation in electronic configurations, which indeed determine the chemistry physical and chemical properties of elements and their compounds.

- Numerous forms of Periodic Table have been devised from time to time. Some forms emphasise chemical reactions and valence, whereas others stress the electronic configuration of elements. A modern version, the so-called "long form" of the Periodic table of the elements, is the most convenient and widely used. The horizontal rows (which Mendeleev called series) are called periods and the vertical columns, groups. Elements having similar outer electronic configurations in their atoms are arranged in vertical columns, referred to as groups or families. According to the recommendation of International Union of Pure and Applied Chemistry (IUPAC), the groups are numbered from 1 to 18 replacing the older notation of groups IA ... VIIA, VIII, IB ... VIIB and 0. There are altogether seven periods.

- The period number corresponds to the highest principal quantum number (n) of the elements in the period. The first period contains 2 elements. The subsequent periods consists of 8, 8, 18, 18 and 32 elements, respectively. The seventh period is incomplete and like the sixth period would have a theoretical maximum (on the basis of quantum numbers) of 32 elements. In this form of the Periodic Table, 14 elements of both sixth and seventh periods (lanthanoids and actinoids, respectively) are placed in separate panels at the bottom.

QUESTION

Which statements is wrong for the long form of periodic table ?

A 18 Elements are present in 5th period ✓

B No. of valence shell electrons in a period are same (Outer) ✗

C 3rd group contains 32 elements ✓

D Lantanides and actinides are placed in same group ✓

QUESTION

Lanthanoids are :- [AIPMT 2004]

A 14 elements in the seventh period (Atomic no.= 58 to 71) that are filling 4f sub level

B 14 elements in the sixth period (atomic no.= 90 to 103) that are filling 4f sublevel

C 14 elements in the seventh period (atomic no.= 90 to 103) that are filling 5f sublevel

D 14 elements in the sixth period (atomic no=58 to 71) that are filling 4 f sublevel

QUESTION

Which of the following is not an actinoid ?

H.W

A Curium (Z = 96)

B Californium (Z = 98)

C Uranium (Z = 92)

D Terbium (Z = 65)

QUESTION

The elements in which electrons are progressively filled in 4f-orbital are called

f Block

A actinoids

B transition elements

C lanthanoids

D halogens

H.W

QUESTION

The element with atomic numbers 35, 53, and 85 are all _____ .

A noble gases

B halogens

C heavy metals

D light metals

17 Halogens

18 Inert

9

17

35

10

18

36

QUESTION

Largest group of periodic table is :

H.W

A 18

B 16

C 2

D 3

QUESTION

Last element of 5th period is :

A Br

B Rn

C Xe

D Og

QUESTION

Total number of d block elements present in 3 period are :

A 10

B 0

C 18

D 32

H.W

QUESTION

Total number of elements present in f block are :

H.W

A 14

B 28

C 32

D 18

QUESTION

Which of the following atomic number belongs to s block :

A 35

B 68

C 55

D 21

QUESTION

$p^6 \longrightarrow 6p^6$

The last element of the p-block in 6th period is represented by the outermost electronic configuration.

A $7s^2\ 7p^6$

B $5f^{14}\ 6d^{10}\ 7s^2\ 7p^0$

C $4f^{14}\ 5d^{10}\ 6s^2\ 6p^6$

D $4f^{14}\ 5d^{10}\ 6s^2\ 6p^4$

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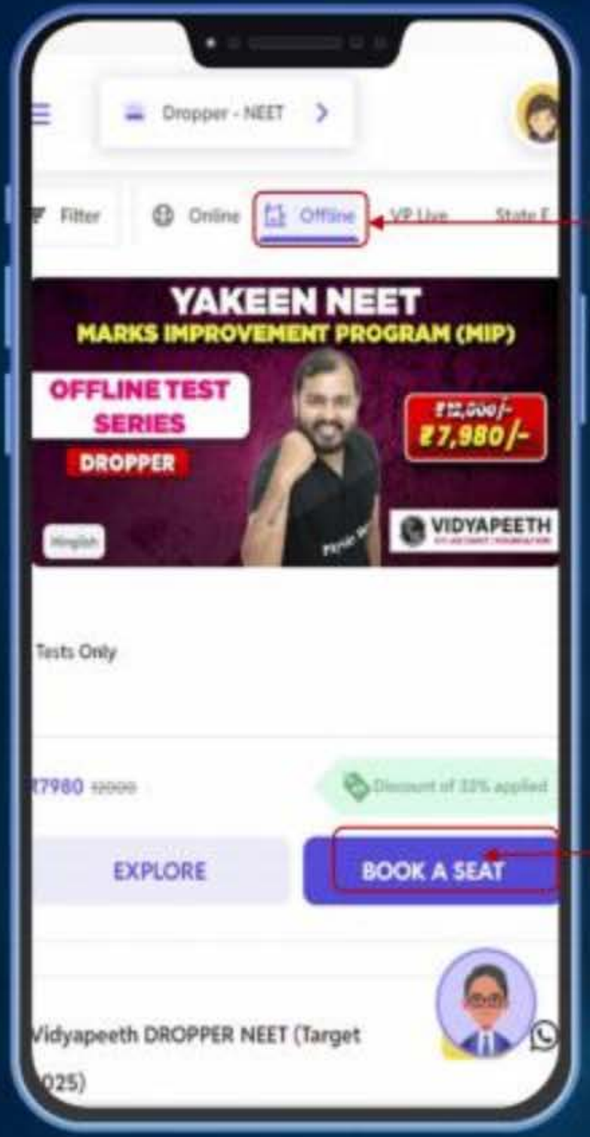

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Lecture-03 | Inorganic Chemistry

Classification of Elements and Periodicity in Properties

By - Mohit Dadheech (MD Sir)

Topics *to be covered*

1. Electronic configurations of d & f Blocks.
2. Group, Block, Period identification

(Except 1st Period)

Each Period in P.T starts with a Subshell of new shell (s) and ends with :-

(1) next shell

(2) Same Subshell

(3) p Subshell of ~~next~~ shell

(4) p Subshell of Same Shell.

$ns \rightarrow (n-2)f \rightarrow (n-1)d \rightarrow np$

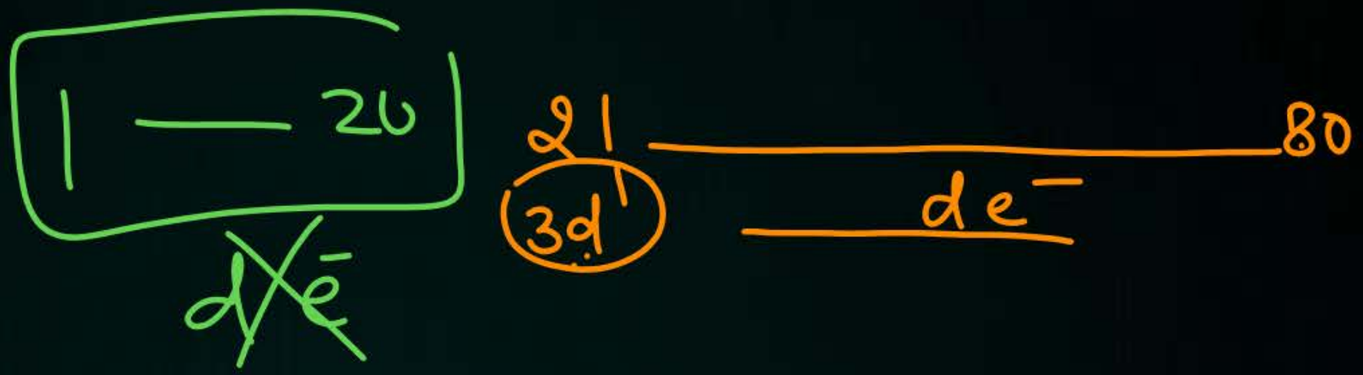
Q out of First 80 elements how many have $d\ \bar{e}$

(1) 80

(2) 20

(3) 60

(4) 40



$80 - 20 = 60$

Q Total no. of "s" e^- in Unipositive ion of element having Z=55

Cs $[Xe]\ 6s^1$

Unipositive Cs^+ $[Xe]\ 6s^0$

$1s\ 2s\ 3s\ 4s\ 5s$

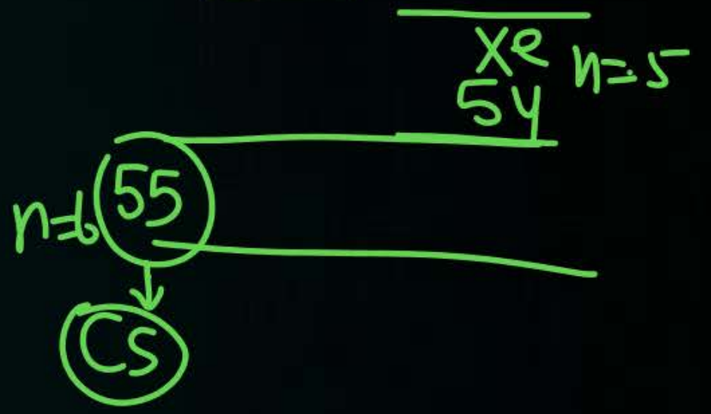
Total "s" e^- $2+2+2+2+2 = 10e^-$

Total "p" e^- ~~1p~~ $2p\ 3p\ 4p\ 5p$ $6+6+6+6 = 24$

Total "d" e^- ~~2d~~ ~~3d~~ $3d\ 4d$ $10+10 = 20\ e^-$

Z=55 → Period

n=6



Q An Element which belongs to 3rd period & 15th group is :–

(1) $1s^2 2s^2 2p^6 3s^2$ ✗

(2) $1s^2 2s^2 2p^6 3s^2 3p^3$ ✓

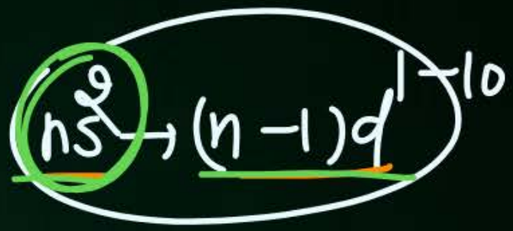
(3) $1s^2 2s^2 2p^3$ ✗

(4) $[Ne]\ 3s^2 3p^5$ ✗

15th group → $ns^2 np^3$ → $3s^2 3p^3$

Block wise General Electronic Configuration :

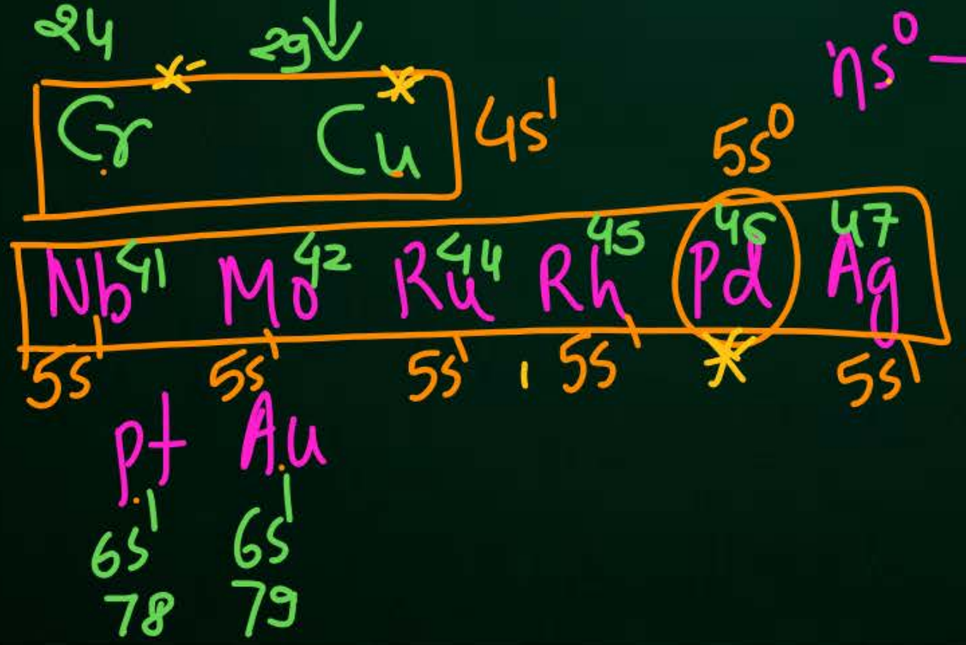
d-block → $ns^{0/1/2}(n-1)d^{1-10}$ or $(n-1)d^{1-10}\ ns^{0/1/2}$



ns^2 → Normal

ns^1 → Exceptional

ns^0 → Exceptional (Only For One Element ⇒ Pd, Z = 46)



$ns \rightarrow (n-1)d$

d - Block

- 3d series: Sc (21) ⟶ Zn (30) (n = 4)
- 4d series: Y (39) ⟶ Cd (48) (n = 5)
- 5d series: La, Hf (57, 72) ⟶ Hg (80) (n = 6)

3d Series :- (n=4) Pre·Inertgas = [Ar]

4s → 3d

Sc [Ar] $4s^2 3d^1$

Ti [Ar] $4s^2 3d^2$

V [Ar] $4s^2 3d^3$

Cr [Ar] ~~$4s^2 3d^4$~~ $4s^1 3d^5$

Mn [Ar] $4s^2 3d^5$

Fe [Ar] $4s^2 3d^6$

Co [Ar] $4s^2 3d^7$

Ni [Ar] $4s^2 3d^8$

Cu [Ar] ~~$4s^2 3d^9$~~ $4s^1 3d^{10}$

Zn [Ar] $4s^2 3d^{10}$

MDJ

$3d^4$ $3d^9$ XX

$3d^5$ $3d^{10}$ Repeats.

4d Series (n=5) Pre Inertgas [Kr] [Kr] $5s \rightarrow 4d$

Y [Kr] $5s^2 4d^1$

Zr [Kr] $5s^2 4d^2$

* Nb [Kr] ~~$5s^2 4d^3$~~ $5s^1 4d^4$

* Mo [Kr] ~~$5s^2 4d^4$~~ $5s^1 4d^5$

Tc [Kr] $5s^2 4d^5$

* Ru [Kr] ~~$5s^2 4d^6$~~ $5s^1 4d^7$

* Rh [Kr] ~~$5s^2 4d^7$~~ $5s^1 4d^8$

* Pd [Kr] ~~$5s^2 4d^8$~~ ~~$5s^1 4d^9$~~ $5s^0 4d^{10}$

* Ag [Kr] ~~$5s^2 4d^9$~~ $5s^1 4d^{10}$

Cd [Kr] $5s^2 4d^{10}$

MDT

$4d^3$, $4d^6$, $4d^9$ XX

$4d^5$, $4d^{10}$ Repeats.

5d series :-

$n = 6$ Pre Inert gas [Xe]

[Xe] 6s → 4f → 5d

MDT

$5d^8$ XX

$5d^{10}$ Repeats.

57 La [Xe] $6s^2\ 4f^0\ 5d^1$

72 Hf [Xe] $6s^2\ 4f^{14}\ 5d^2$

Ta [Xe] $6s^2\ 4f^{14}\ 5d^3$

W [Xe] $6s^2\ 4f^{14}\ 5d^4$

Re [Xe] $6s^2\ 4f^{14}\ 5d^5$

Os [Xe] $6s^2\ 4f^{14}\ 5d^6$

Ir [Xe] $6s^2\ 4f^{14}\ 5d^7$

Pt [Xe] ~~$6s^2\ 4f^{14}\ 5d^8$~~ $6s^1\ 4f^{14}\ 5d^9$

Au [Xe] ~~$6s^2\ 4f^{14}\ 5d^9$~~ $6s^1\ 4f^{14}\ 5d^{10}$

Hg [Xe] $6s^2\ 4f^{14}\ 5d^{10}$

Block wise General Electronic Configuration :

f-block $\rightarrow ns^2 (n-2)f^{1-14} (n-1)d^{0/1}$

$ns \rightarrow (n-2)f \rightarrow (n-1)d^0 \rightarrow np$

1-14

$(n-1)d^0$ Normal.

$(n-1)d^1$ Exceptional.

$(n-1)d^2 \rightarrow$ Exceptional only For Th $Z=90$

Lanthanoids 4f series

58	64	71
Ce	Gd	Lu.
$5d^1$	$5d^1$	$5d^1$

Actinoids

91	92	93	96	103
Pa	U	Np	Cm	Lr
$6d^1$	$6d^1$	$6d^1$	$6d^1$	$6d^1$

Lanthanoids (4f series)

58 Ce [Xe] $6s^2$ $4f^1$ $5d^1$
59 Pr [Xe] $6s^2$ $4f^3$ $5d^0$
60 Nd [Xe] $6s^2$ $4f^4$ $5d^0$
61 Pm [Xe] $6s^2$ $4f^5$ $5d^0$
62 Sm [Xe] $6s^2$ $4f^6$ $5d^0$
63 Eu [Xe] $6s^2$ $4f^7$ $5d^0$
64 Gd [Xe] $6s^2$ $4f^7$ $5d^1$
65 Tb [Xe] $6s^2$ $4f^9$ $5d^0$
66 Dy [Xe] $6s^2$ $4f^{10}$ $5d^0$
67 Ho [Xe] $6s^2$ $4f^{11}$ $5d^0$
68 Er [Xe] $6s^2$ $4f^{12}$ $5d^0$
69 Tm [Xe] $6s^2$ $4f^{13}$ $5d^0$
70 Yb [Xe] $6s^2$ $4f^{14}$ $5d^0$
71 Lu [Xe] $6s^2$ $4f^{14}$ $5d^1$

or [Xe] 4f 5d 6s

MDJ = 1 → $4f^0$, $4f^2$, $4f^8$ ✗✗ $4f^7$, $4f^{14}$ Repeats

or

MDJ-2

↳ Abtak 56 Bharo.

[Xe] + $6s^2$

54 + 2 = 56 e^-

Remaining $\bar{e}$ in 4f

* Ce Gd Lu ⇒ $5d^1$

Actinoids - 5f series

90	Th	$[Rn]\ 7s^2\ 5f^0\ 6d^2$
91	Pa	$[Rn]\ 7s^2\ 5f^2\ 6d^1$
92	U	$[Rn]\ 7s^2\ 5f^3\ 6d^1$
93	Np	$[Rn]\ 7s^2\ 5f^4\ 6d^1$
94	Pu	$[Rn]\ 7s^2\ 5f^6\ 6d^0$
95	Am	$[Rn]\ 7s^2\ 5f^7\ 6d^0$
96	Cm	$[Rn]\ 7s^2\ 5f^7\ 6d^1$
97	Bk	$[Rn]\ 7s^2\ 5f^9\ 6d^0$
98	Cf	$[Rn]\ 7s^2\ 5f^{10}\ 6d^0$
99	Es	$[Rn]\ 7s^2\ 5f^{11}\ 6d^0$
100	Fm	$[Rn]\ 7s^2\ 5f^{12}\ 6d^0$
101	Md	$[Rn]\ 7s^2\ 5f^{13}\ 6d^0$
102	No	$[Rn]\ 7s^2\ 5f^{14}\ 6d^0$
103	Lr	$[Rn]\ 7s^2\ 5f^{14}\ 6d^1$

or $[Rn]\ \underline{5f\ 6d\ 7s}$

(MDJ) - 1

$5f^1$ $5f^5$ $5f^8$ ✗✗
$5f^7$ $5f^{14}$ Repeats

(MDJ) - 2

$[Rn] + 7s^2 = 88e^-$

- Ab tak 88 Bharo.
- Remaining e^- 5f Mai

→ Th → $6d^2$

→ 91 92 93 96 103

$6d^1$

Period, Block & Group Identifications :-

Case-I When atomic no (Z) is given

(1) Period no (n) of given Z = n of next inert gas

(2) group No.

$$Z_{given} + 18 - Z_{next\ inert\ gas}$$

* If value comes in -ve then use 32 in Formula.

$$Z_{given} + 32 - Z_{next\ inert\ gas}$$

* do not use this formula For atomic No. Z = 1 to 12

③ Block on the basis of group No.

gp No.	Block
1 – 2	s
3 – 12	d
13 – 18	p

(Note) all f Block element have 3rd group

④ if $58 \leq Z_{given} \leq 71$ → Lanthanoids $n=6$, group = 3, Block f

⑤ if $90 \leq Z_{given} \leq 103$ Actinoids $n=7$ group = 3, Block f

⑥ if $104 \leq Z_{given} \leq 118$ group No = Last two digit of "Z", $n=7$, (Block) 104 – 112 (d)
113 – 118 p

Ex $Z = 33$ next inertgus = 36 $n=4$

Period no.(n) = 4

group no. = $33+18-36 = 15$

Block = p Block.

Ex-2 $Z = 57$ Next inert gus → 86 $n=6$

$n=6$

group No. $57+18-86$

$75-86 = -11$ ✗

$57+32-86$

$89-86 = 3$ ✓

Block = d

H.W

Atomic No. (Z)	Period	group	Block
68			
71			
95			
35			
83			
56			
95			
109			
111			

Case-II When e^- Configuration is given

* **Period no :-** maximum Value of "n" in given Configuration

$1s^2 2s^2 2p^6 \underbrace{3s^2\ 3p^5}_{n^{th}}$ $n=3$

* **Block :-** decided by Subshell in which Last-e^- enters.

* **group No.**

S-Block $\Rightarrow$ gp No $=$ ns e^-

p-Block $\Rightarrow$ gp No $=$ $12 + np\ e^-$

d-Block $\Rightarrow$ gp No. $=$ $ns + (n-1)d\ e^-$

f-Block $\rightarrow$ Always 3rd group

H.W

e⁻ configuration | Period no. | Block | group.

$[Xe]\ 6s^2$

$[Xe]\ 6s^2\ 4f^7\ 5d^1$

$[Ar]\ 4s^2\ 3d^{10}$

* $[Kr]\ 4d^{10}$

$[Rn]\ 7s^2\ 5f^{14}$.

$[Ne]\ 3s^2\ 3p^3$

$[Ar]\ 4s^2\ 3d^{10}\ 4p^2$

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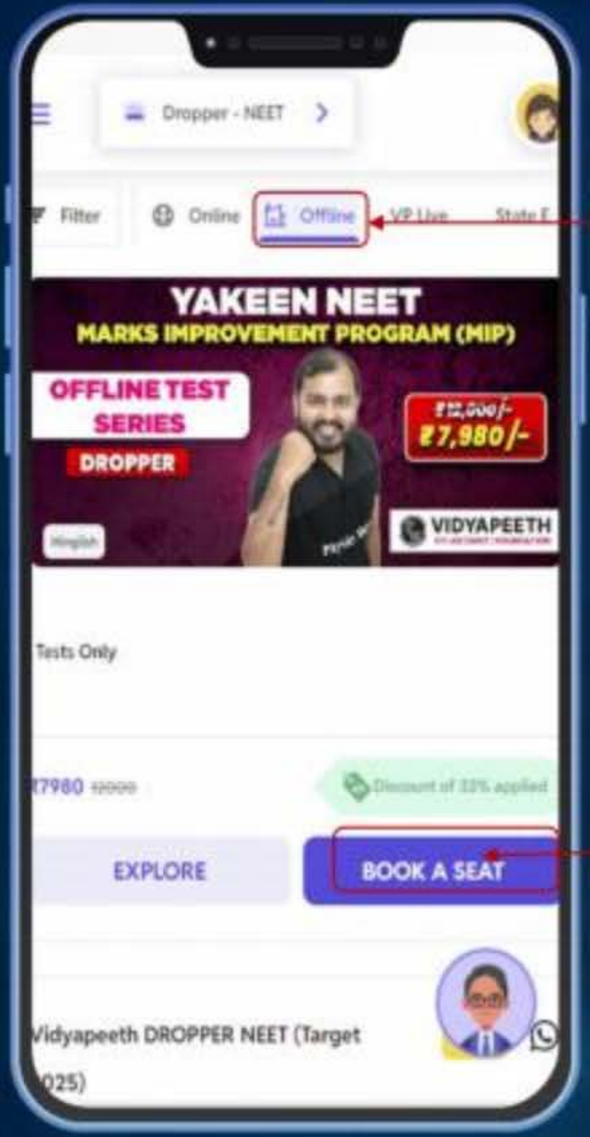

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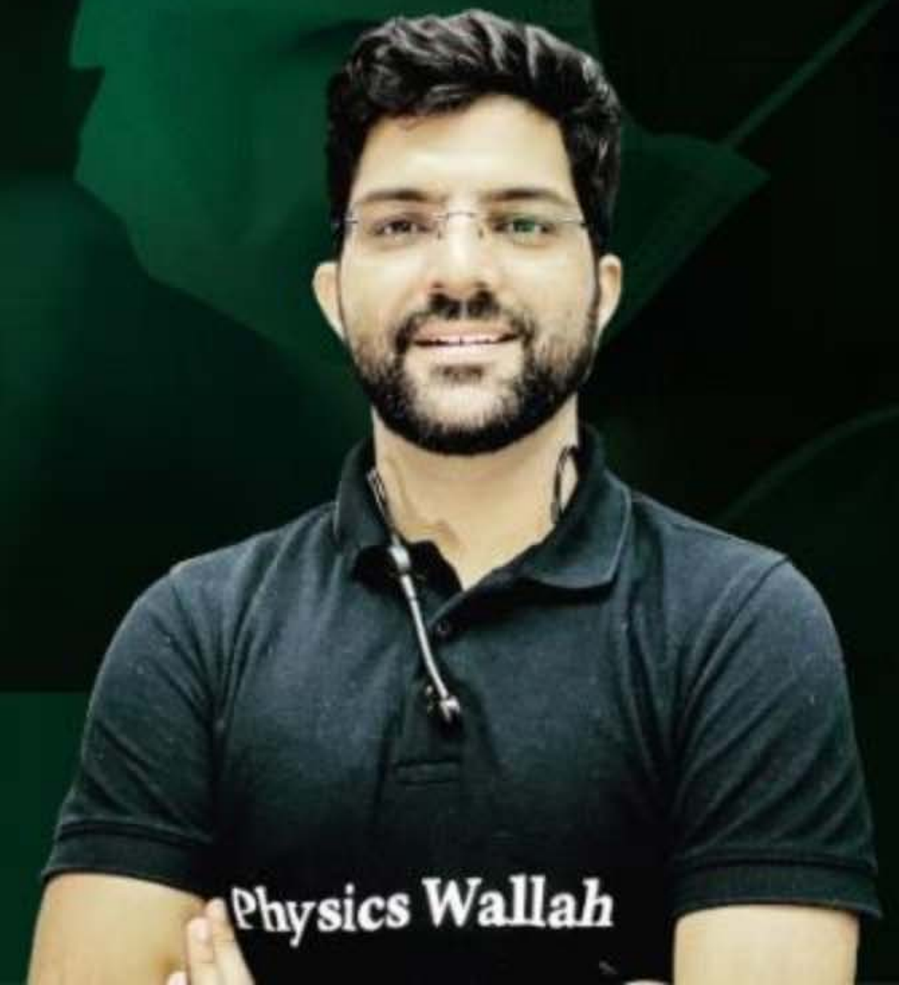
FOR NEET 2025

Lecture- 04 | Inorganic Chemistry

Classification of Elements and Periodicity in Properties



By - Mohit Dadheech (MD Sir)

Topics *to be covered*

1. Screening Effect & Effective Nuclear charge

H.W

Atomic No. (Z)	Period	group	Block
68	6	3	f
71	6	3	f
95	7	3	f
35	4	17	p
83	6	15	p
56	6	2	s
95	4	7	d
109	7	9	d
111	7	11	d

H.W

e⁻ configuration	Period no.	Block	group
$[Xe]\ \underline{6s^2}$	6	s	2 $(ns\,e^-)$
$[Xe]\ \underline{6s^2}\ 4f^7\ 5d^1$	6	f	3
$[Ar]\ \underline{4s^2}\ 3d^{10}$	4	d	12 $(ns\,e^- + (n-1)d\,e^-)$
$[Kr]\ 4d^{10}\ \underline{5s^0}$ ($_{36}$, $2 = 2d$, $46 - 36 = 10$)	~~4~~ 5	d	10 $(\rightarrow 1, \longrightarrow n)$
$[Rn]\ \underline{7s^2}\ 5f^{14}$	7	f	3
$[Ne]\ 3s^2\ \underline{3p^3}$ (np)	3	p	15 $(12 + np\,e^-)$
$[Ar]\ 4s^2\ 3d^{10}\ \underline{4p^2}$ (np)	4	p	14 $(12 + np\,e^-)$

NOTE

① If np e^- are present then p Block is Confirmed

$ns \rightarrow \underline{(n-2)f \rightarrow (n-1)d} \rightarrow (np)$

np^{1-6}

② For s-Block element $\bar{e}$ must not be present into $\underline{(n-2)f \ \& \ (n-1)d}$ subshells

$[Ar]\ 3d^5\ (4s^1)$ ns^1 ~~s-Block~~

$(n-1)d$ (n)

d-Block ✓ ∵ $\bar{e}$ are present in $(n-1)d$

$[Xe]\ 4f^4\ 5d^0\ (6s^2)$ ns^2 - ~~s-Block~~

$(n-2)f\ (n-1)d$

f-Block ✓ ∵ $\bar{e}$ are present in $(n-2)f$

QUESTION

Which of the following electronic configuration does not belong to same block as others :

A [Xe] $4f^{14}\ 5d^{10}\ 6s^2$ — d Block

B [Kr] $4d^{10}\ 5s^2$ — d-Block

C [Kr] $5s^2$ — s-Block.

D [Ar] $3d^6\ 4s^2$ — d-Block

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 5s^2$

$(n-4)$ $(n-3)$ $(n-2)$ $(n-1)^{th}$ n^{th}

QUESTION

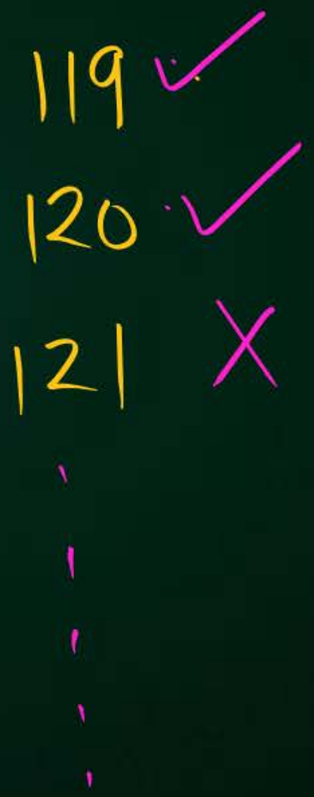
Which of the elements whose atomic number are given below, cannot be accommodate in the present set up of the long form of the periodic table

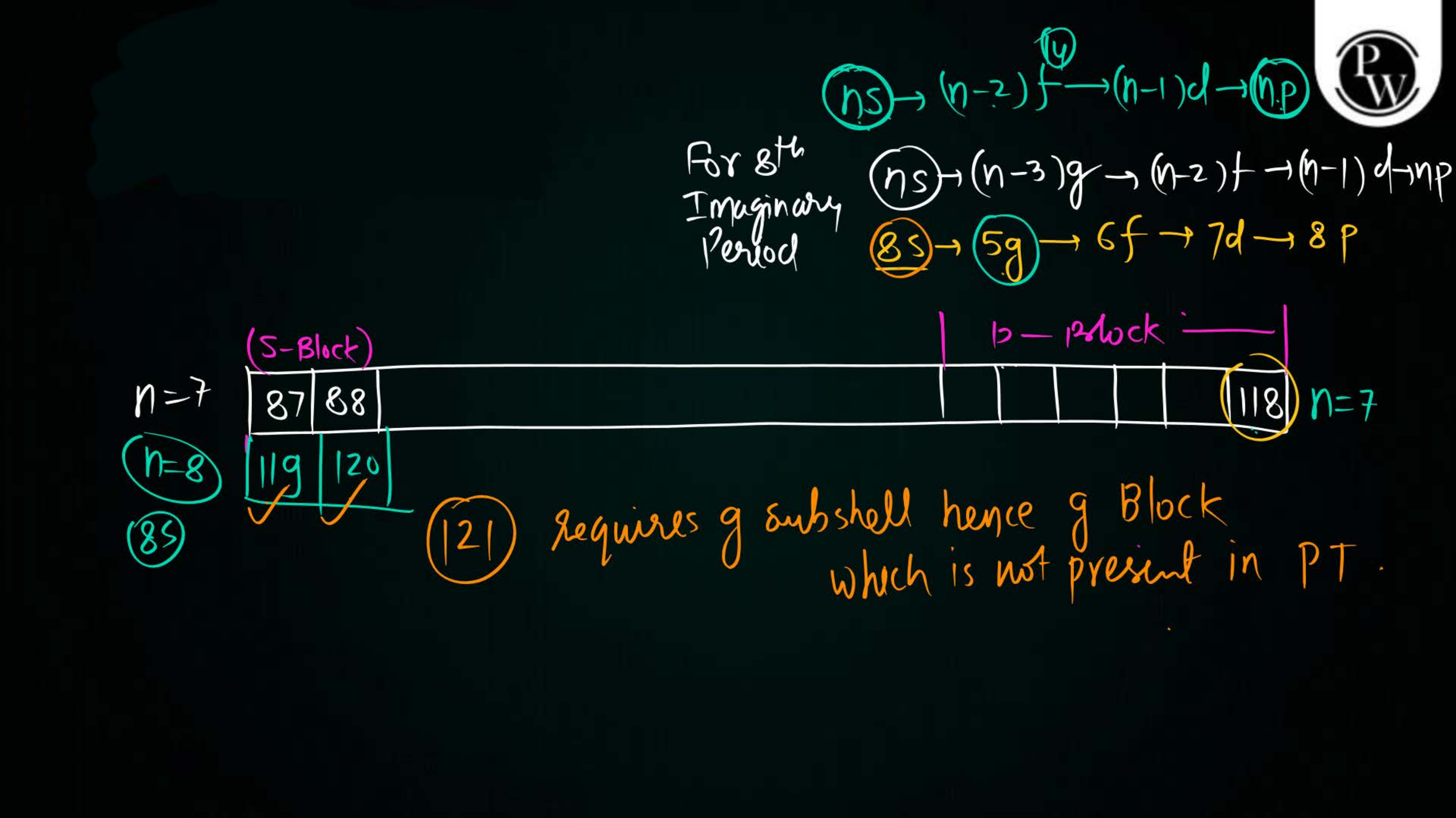
A 107

B 118

C 126

D 102




ns → (n-2)f (4) → (n-1)d → np
For 8th Imaginary Period
ns → (n-3)g → (n-2)f → (n-1)d → np
8s → 5g → 6f → 7d → 8p
(S-Block)
p-Block
n=7
87
88
118
n=7
n=8
119
120
8s
121 requires g subshell hence g Block which is not present in PT.

QUESTION

Minimum atomic number that can change the model of modern periodic table: (follow n + ℓ rule)

A 119

B 121

C 132

D 150

QUESTION

Which of the following electronic configurations in the outermost shell is characteristic of alkali metals

n = 4

A $(n-1)\ s^2p^0\ ns^2p^1$ ✗ $3s^2\ 3p^0\ 4s^2\ 4p^1$

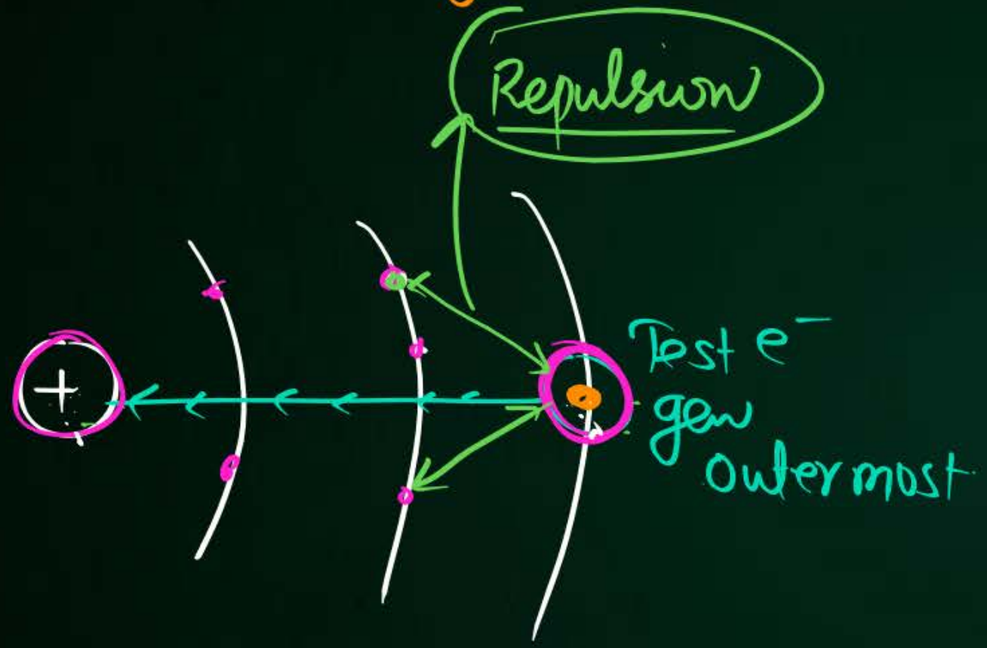
B $(n-1)\ s^2p^6d^{10}\ ns^1$ ✗ $3s^2\ 3p^6\ 3d^{10}\ 4s^1$ ($n-1$)d (n) ns^1 s-Block ✗ d-Block

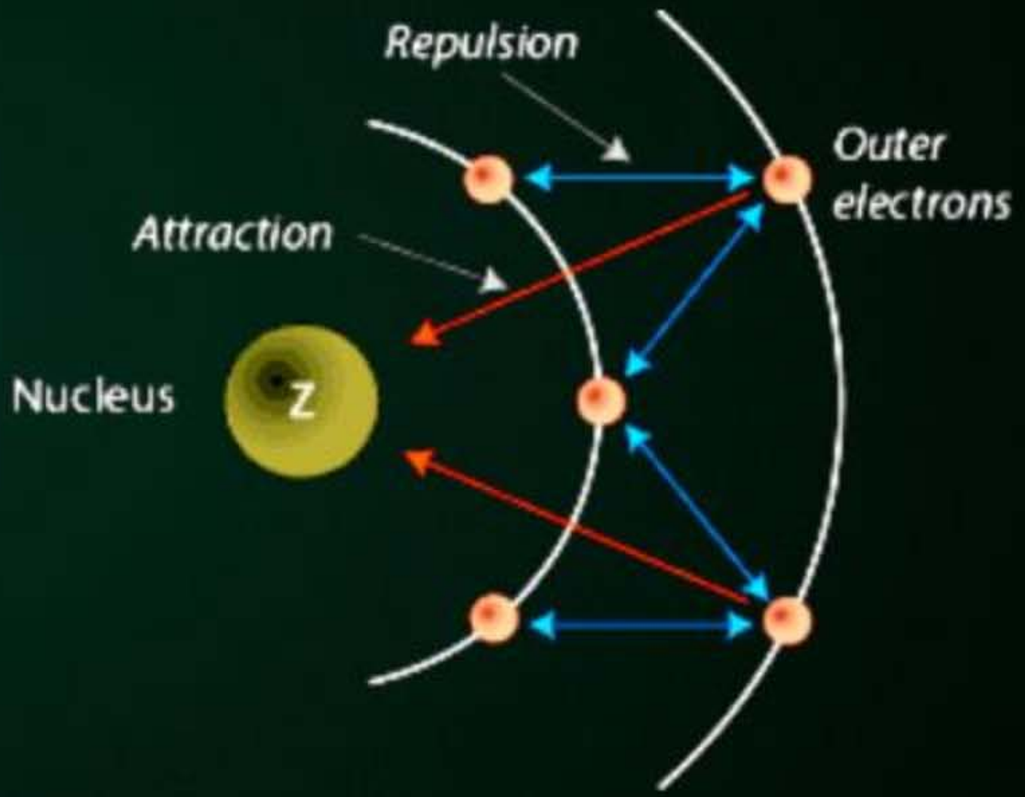
C $(n-1)\ s^2p^6\ ns^1$ $3s^2\ 3p^6\ 4s^1$ ✓ s-Block

D $ns^2np^6(n-1)d^{10}$ $4s^2\ 4p^6\ 3d^{10}$ $3d^{10}\ 4s^2\ 4p^6$ p-Block

Screening Effect & Effective Nuclear charge

or shielding





Screening / shielding Effect (σ)

Tendency of Inner shell's e^- to Protect outer test e^- From nuclear charge.

or

Repulsive force Exerted by inner e^- towards outermost test e^-

Effective Nuclear charge (Z_{eff})

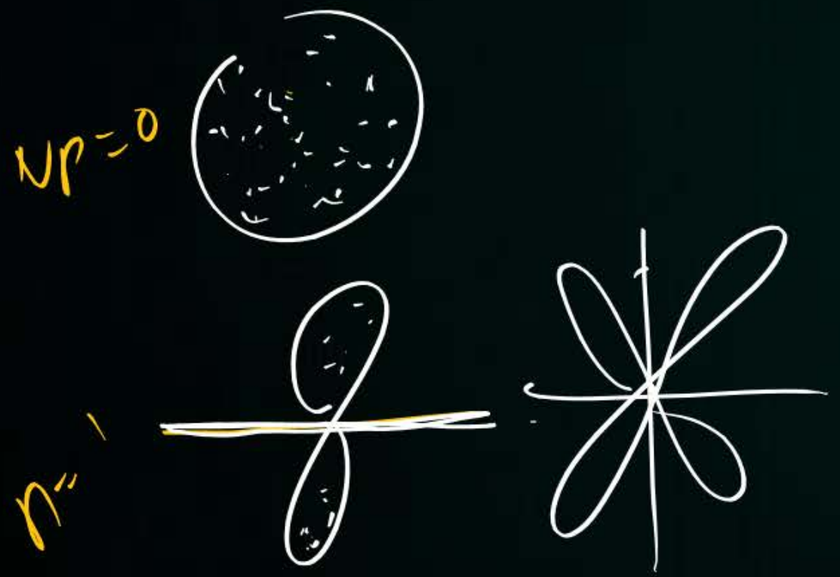
$$Z_{eff} = Z - \sigma$$

- Z_{eff}: Net force of Attraction
- Z: Total Attraction, no. of p^+
- σ: Repulsion.

$\Rightarrow$ Net Force of attraction on Outermost test e^-

Order of shielding

For different subshells of same shell :-



$$s > p > d > f$$

Poor shielding (σ)

Very poor shielding (σ)

↓

due to their diffused shape.

$\therefore$ $\bar{e}$ density Low

$s > p > \underbrace{d > f}_{\text{Poor } \sigma}$

$\uparrow Z_{eff} = Z - \textcircled{\sigma}\downarrow$

$Z_{eff} \propto \frac{1}{\sigma}$

$Z_{eff} \uparrow$ net attraction on outer $e^- \uparrow$

Contraction $\uparrow_{se} \longrightarrow$ Size $\downarrow$

Contraction

(TC) Transition Contraction
due poor σ of 3d e^-

(LC) Lanthanoid contraction
due to poor σ of 4f e^-

(AC) Actinoid Contra-
due to poor σ of 5f e^-

order of shielding 3d > 4f > 5f

Strength of Contraction T.C < L.C < A.C

THANK YOU

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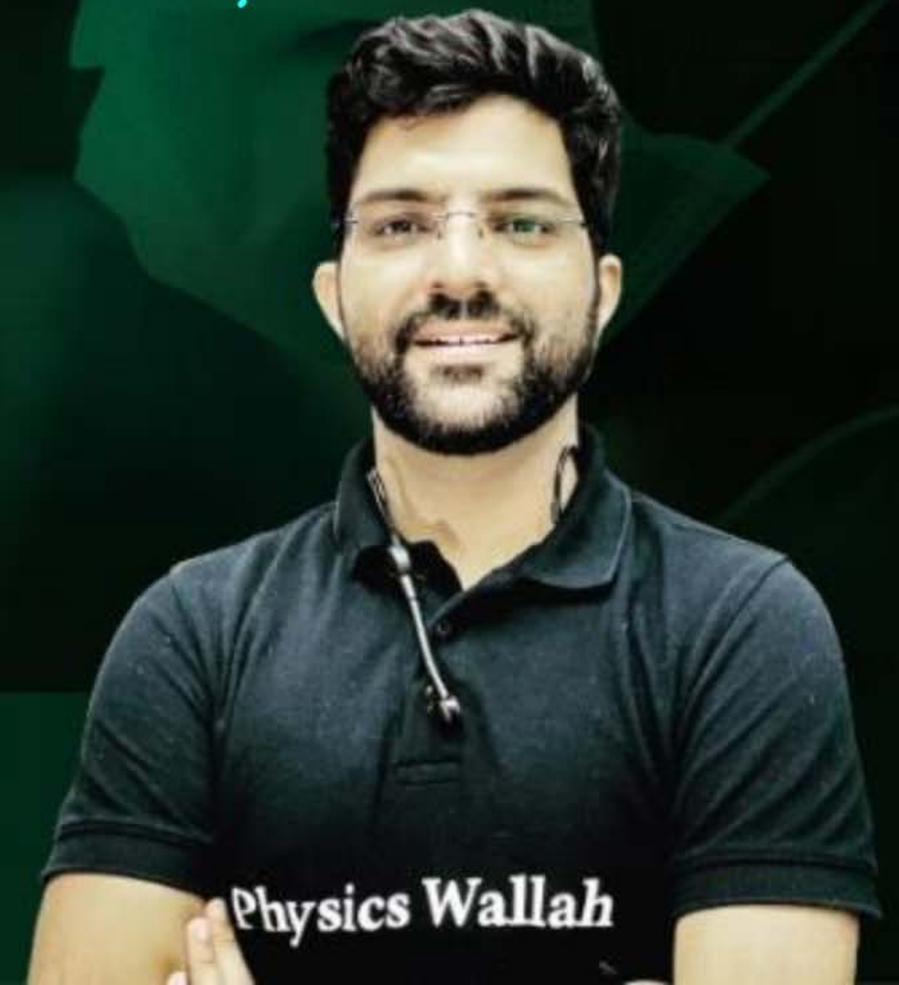
FOR NEET 2025

Lecture- 05 | Inorganic Chemistry

Classification of Elements and Periodicity in Properties



By - Mohit Dadheech (MD Sir)

Topics *to be covered*

1. Atomic radius (Size)

On the Basis of Vaules it has been found that :-

For S & P Block

* On moving Left to right in a period generally
  Zeff ↑se
* on moving top to bottom in a group. generally.
  Zeff remains Constant.

Period	Element	Li	Be	B	C	N	O	F
	Z_{eff}	1.30	1.95	2.60	3.25	3.90	4.55	5.20

+0.65 +0.65

Group	
Element	Z_{eff}
Li	1.30
Na	2.20
K	2.20
Rb	2.20
Cs	2.20
Fr	2.20

+0.90

Constant

More rise

L → R : n constant, σ ↑, Z_{eff} ↑↑

T ↓ B : n rise, σ ↑, Z_{eff} constant

Z_{eff} in Isoelectronic Species & ions of Same element

(1) Isoelectronic Species :—

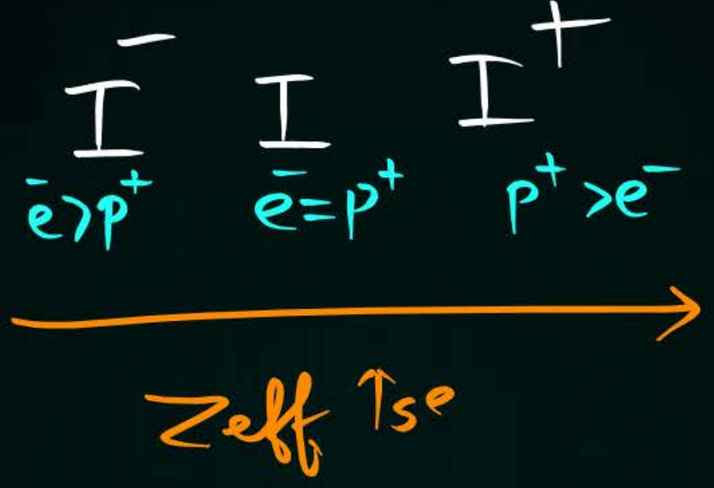
Isoelectronic → Same no. of e^-

	Al^{3+}	Mg^{2+}	Na^+	F^-	O^{2-}	N^{3-}
p^+	13	12	11	9	8	7
e^-	10	10	10	10	10	10

Z_{eff} ↓se.

Z_{eff} in isoelectronic $\propto$ $\frac{+ve}{-ve}$ (p^+ / e^-)

Ions of Same element

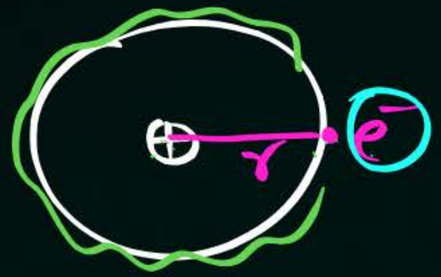


$O < O^+$ (Z_{eff})

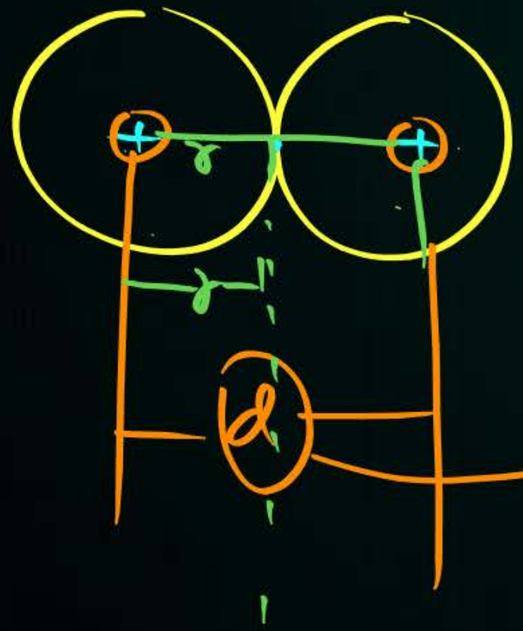
$O^+ < O^{2+}$ (Z_{eff}

$O > O^-$ (Z_{eff})

Size (Radius)



1.2×10^{-10} m



$r = \frac{d}{2}$

Internuclear distance (Bond length)

Size

Finding the Size of an atom is not Practically possible :—

Reasons

(i) Size of an atom is very Small (1.2×10^{-10} m)

(ii) there is no sharp boundary Present in an atom

Thats Why. Radius/Size Can be measured in Bonded/Combined state"

Atomic Radius

Half of distance (Internuclear distance) between the atoms in combined state.

Bonded state

Covalent Bond

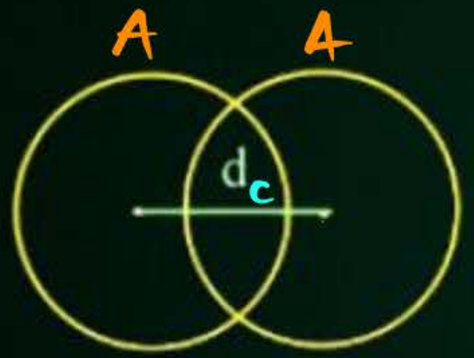
Metallic Bond

Vandrwaal Force

Ionic Bond.

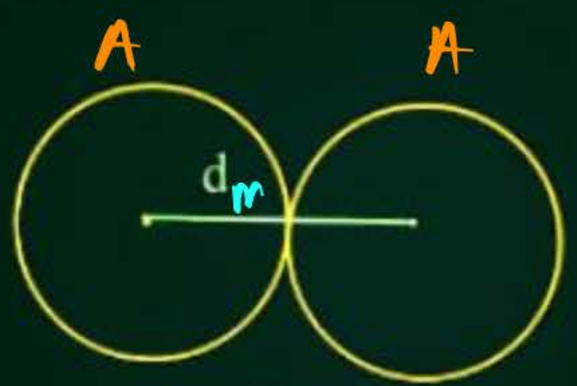
Types of Radius :

(i) Covalent radius
(ii) Metallic radius
(iii) Ionic radius
(iv) Vander waals radius



Covalent radius

$$r_C = \frac{d_c}{2}$$



Metallic radius

$$r_m = \frac{d_m}{2}$$

van der Waals Radius

$$r_v = \frac{d_v}{2}$$

For same element $r_c < r_m < r_v$

$r_v \approx 2 \times r_c$

Ionic radius / Crystal Radius :—

Neutral
$e^- = p^+$

Cation → $p^+ > e^-$. Z_{eff} ↑ . Contraction ↑, Size ↓ se (r^+)

∴ Cation is smaller than its Parent Species

Anion $e^- > p^+$

Z_{eff} ↓ se

Size (r^-) ↑ se

∴ Size of Anion is Larger than Parent species

Ex (i) $O^+ < O < O^-$

(ii) $F < F^-$

(iii) $Mg > Mg^{2+}$

(iv) $Al > Al^{3+}$

(v) $Cl^- > Cl$

(vi) $I^+ < I < I^-$

MDJ

Ionic Radius $\propto \frac{1}{Z_{eff}}$

Ionic Radius $\propto \frac{-ve}{+ve}$

Same can be apply For Isoelectronic series-

V. V. Imp for NEET

Size order in Isoelectronic Series :-

N^{3-} O^{2-} F^{-} Na^{+} Mg^{2+} Al^{3+} →

Z_{eff} ↑se Size ↓se.

Ex Cl^{-} S^{2-} K^{+} Ca^{2+} (size)

$18e^{-}$ $18e^{-}$ $18e^{-}$ $18e^{-}$

$S^{2-} > Cl^{-} > K^{+} > Ca^{2+}$

gen. trend of Size :-

(L → R) n constant, Z_{eff} ↑se Size ↓

(T ↓ B) n ↑ (shell no.)

Size ↑se

Ex

Li > Be > B > C > N > O > F <<< Ne

Na > Mg > Al > Si > P > S > Cl <<< Ar

Inert gas

Vanderwaal Radius (Max. Size)

give Correct order of Size in Following.

(i) $Mg > Al > \underset{10e^-}{Mg^{2+}} > \underset{10e^-}{Al^{3+}}$

(ii) $Li < Na < K < Rb < Cs$

(iii) $F < Cl < Br < I$

(iv) $N < P < As < Sb$

(v) $C < Si < Ge < Sn$

(vi) $O < S < Se < Te$

(vii) $He < Ne < Ar < Kr < Xe$

(viii) $F^- > F$

(ix) $F^- < Cl^- < Br^- < I^-$

(x) $Li^+ < Na^+ < K^+ < Rb^+$

QUESTION

The ions O^{2-}, F^{-}, Na^{+}, Mg^{2+} and Al^{3+} are isoelectronic. Their ionic radii show

[AIPMT 2003]

A an increase from O^{2-} to F^{-} and then decrease from Na^{+} to Al^{3+}

B a decrease from O^{2-} to F^{-} and then increase from Na^{+} to Al^{3+}

C a significant increase from O^{2-} to Al^{3+}

D a significant decrease from O^{2-} to Al^{3+}

QUESTION

Ionic radii are :- [AIPMT 2004]

A Directly proportional to square of effective nuclear charge

B Inversely proportional to effective nuclear charge

C Inversely proportional to square of effective nuclear charge

D Directly proportional to effective nuclear charge

QUESTION

Among the elements Ca, Mg, P and Cl, the order of increasing atomic radii is :-

[AIPMT 2010]

A. Cl < P < Mg < Ca

B. P < Cl < Ca < Mg

C. Ca < Mg < P < Cl

D. Mg < Ca < Cl < P

Mg > P > Cl

Ca

QUESTION

The correct order of the decreasing ionic radii among the following isoelectronic species is :-

[AIPMT 2010]

H.W

A $K^+ > Ca^{2+} > Cl^- > S^{2-}$

B $Ca^{2+} > K^+ > S^{2-} > Cl^-$

C $Cl^- > S^{2-} > Ca^{2+} > K^+$

D $S^{2-} > Cl^- > K^+ > Ca^{2+}$

QUESTION

Identify the wrong statement in the following :

(H.W)

[AIMPT Pre 2011]

A. Atomic radius of the elements increases as one moves down the first group of the periodic table

B. Atomic radius of the elements decreases as one-moves across from left to right in the 2^{nd} period of the periodic table

C. Amongst isoelectronic species, smaller the positive charge on the cation, smaller is the ionic radius

D. Amongst isoelectronic species, greater the negative charge on the anion, larger is the ionic radius

QUESTION

Which of the following orders of ionic radii is correctly represented

[AIPMT 2014]

A $H^- > H^+ > H$

B $Na^+ < F^- < O^{2-}$

C $F^- > O^{2-} > Na^+$

D $Al^{3+} > Mg^{2+} > N^{3-}$

QUESTION

Be^{2+} is isoelectronic with which of the following ions ? [AIPMT 2014]

H.W

A H^+

B Li^+

C Na^+

D Mg^{2+}

QUESTION

Consider the isoelectronic species, Na^+, Mg^{2+}, F^- and O^{2-}. The correct order of increasing length of their radii is _____.

A $F^- < O^{2-} < Mg^{2+} < Na^+$

B $Mg^{2+} < Na^+ < F^- < O^{2-}$

C $O^{2-} < F^- < Na^+ < Mg^2$

D $O^{2-} < F^- < Mg^{2+} < Na^+$

H.W

QUESTION

Which of the following is the correct order of size of the given species.

A $I > I^- > I^+$

B $I^+ > I^- > I$

C $I > I^+ > I$

D $I^- > I > I^+$

H.W

NCERT KI CHOTI CHOTI MAGAR MOTI BAATEIN

Fill in the Blanks :

An electron in an atom is characterised by a set of four Quantum Numbers.

An element's location in the Periodic Table reflects the quantum numbers of the last Orbital filled.

Successive period in the Periodic Table is associated with the filling of the next higher principal energy level. True

Number of elements in each period is twice the number of Orbital available in the energy level that is being filled.

The elements of Group 1 (alkali metals) and Group 2 (alkaline earth metals) which have ns^1 & ns^2 outermost electronic configuration respectively.

Covalent Radius

One practical approach to estimate the size of an atom of a non-metallic element is to measure the distance between two atoms when they are bound together by a single bond in a covalent molecule and from this value, the "Covalent Radius" of the element can be calculated. For example, the bond distance in the chlorine molecule (Cl_2) is 198 pm and half this distance (99 pm), is taken as the atomic radius of chlorine.

$d_C = 198$ $\quad r_C = \frac{198}{2}$

For metals, we define the term "Metallic Radius" which is taken as half the internuclear distance separating the metal cores in the metallic crystal. For example, the distance between two adjacent copper atoms in solid copper is 256 pm; hence the metallic radius of copper is assigned a value of 128 pm.

d_M $\quad r_M = d_M/2$

For simplicity, in this book, we use the term Atomic Radius to refer to both covalent or metallic radius depending on whether the element is a non-metal or a metal.

The atomic size generally decreases across a period for the elements. It is because within the period the outer electrons are in the same valence shell and the effective nuclear charge increases as the atomic number increases resulting in the increased attraction of electrons to the nucleus. Within a family or vertical column of the periodic table, the atomic radius increases regularly with atomic number.

Li < Na < K < Rb < Cs F < Cl < Br < I

For alkali metals and halogens, as we descend the groups, the principal quantum number (n) increases and the valence electrons are farther from the nucleus. This happens because the inner energy levels are filled with electrons, which serve to shield the outer electrons from the pull of the nucleus. Consequently the size of the atom increases as reflected in the atomic radii.

Note that the atomic radii of noble gases are not considered here. Being monoatomic, their (non-bonded radii) values are very large. In fact radii of noble gases should be compared not with the covalent radii but with the van der Waals radii of other elements.

THANK YOU

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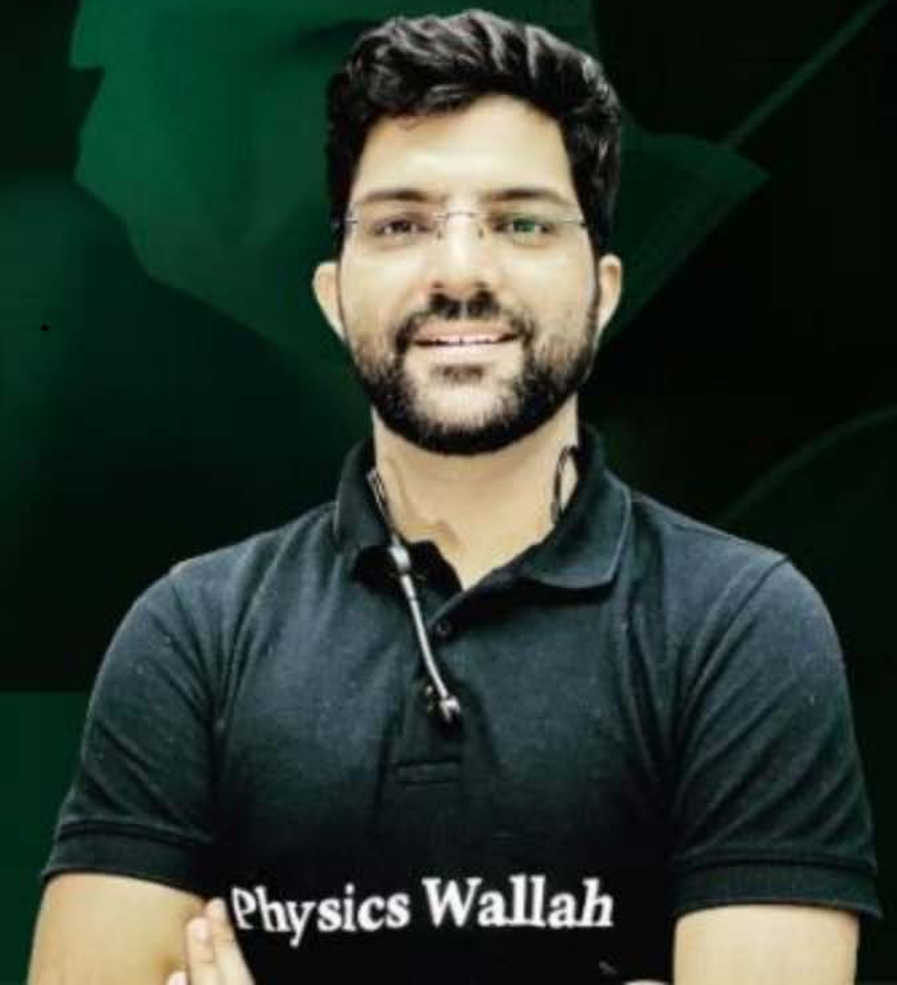
FOR NEET 2025

Lecture- 06 | Inorganic Chemistry

Classification of Elements and Periodicity in Properties

By - Mohit Dadheech (MD Sir)



Topics *to be covered*

1. Blockwise size
2. Ionization Energy

Blockwise Size

S-Block (No Exception)

group-1	group-2
Li	Be
↑	↑
Na	Mg
↑	↑
K	Ca
↑	↑
Rb	Sr
↑	↑
Cs	Ba

T → B Size ↑se ($\because n \uparrow$)

L → R Size ↓se (in a particular period)
($\because Z_{eff} \uparrow$se)

Ex

Li > Be

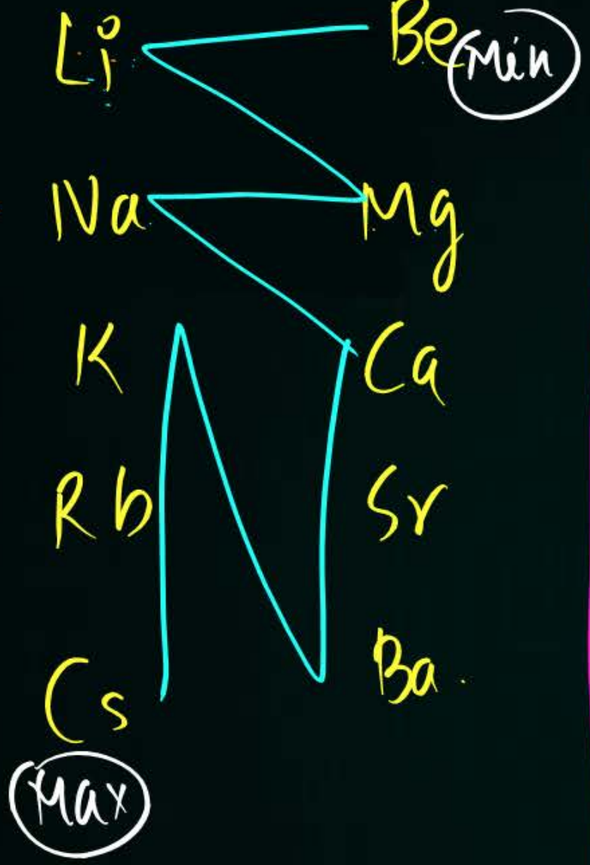
Na > Mg

K > Ca

- - -

- - -

Size order For Complete S-Block



Same trick can be applied for their respective ions also. With only one change.

$$Li^{+} \geq Mg^{2+}$$

$$Be^{2+} < Mg^{2+} < Li^{+} < Na^{+} < Ca^{2+} < Sr^{2+} < Ba^{2+}$$

$$< K^{+} < Rb^{+} < Cs^{+}$$

p- Block

From Gsoup 14th to 18th their is no exception Means Size ↑se down the group.

13th

B
Al
Ga
In
Tl

$[Ne]\,3s^2\,3p^1$

$[Ar]\,3d^{10}\,4s^2\,4p^1$

Sc $2\,1\;d^1$ — Zn $3\,0\;d^{10}$ — 31 — Ga

10 $d\bar{e}$ have poor ⌐

Zeff ↑se, Contraction ↑, Size ↓se

Transition contraction

d-Block

(L → R) only 3d series

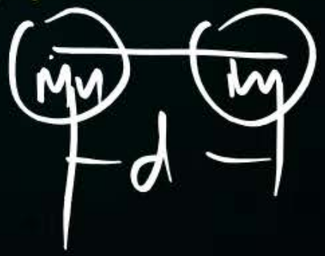
order based on data given in NCERT 12th Part-I

$Sc < Ti < V < Cr > Mn < Fe \simeq Co \simeq Ni < Cu < Zn$

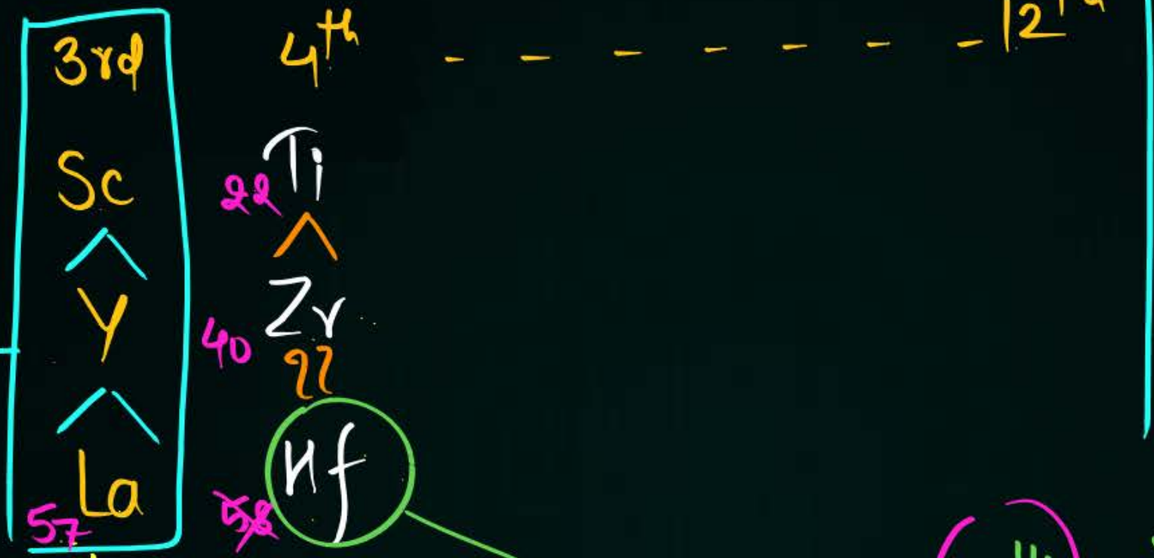
* $Sc > Zn$
* $Mn \simeq Zn$

$Mn \rightarrow 3d^5 4s^2$

- Stable Half Filled Configuration
- less tendency to participate in Metallic Bonding
- Weak Metallic Bonding
- More internuclear distance → r_m ↑ Size ↑



T → B d-Block



Except 3rd group

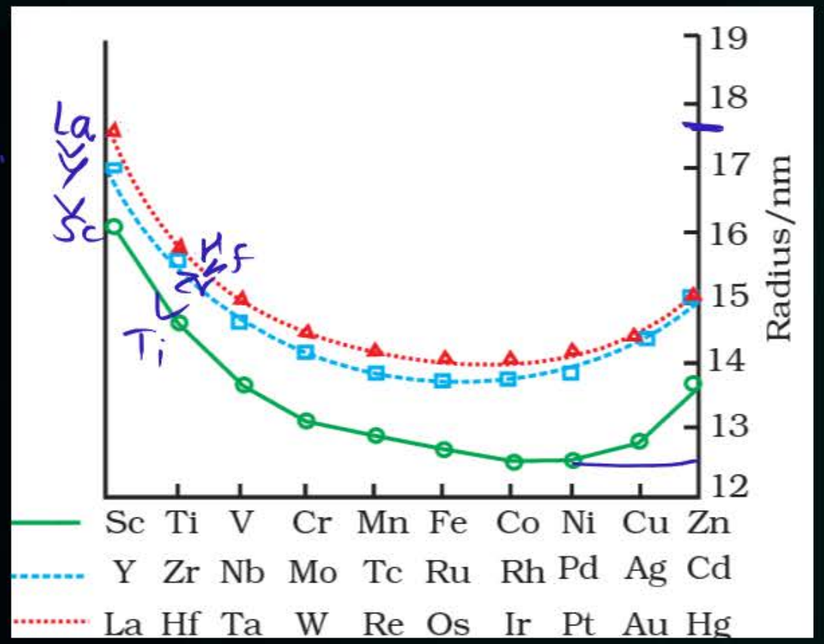
Size of 5d series elements become similar to 4d series due to Lanthanoid Contraction

Normal Top to Bottom Size ↑se

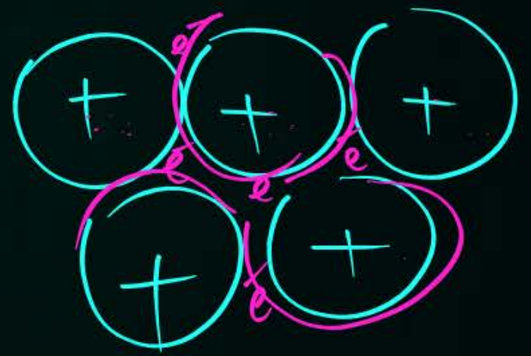
58 to 71
Lanthanoids
$4f e^-$

$[Xe]\ 4f^{14}\ 5d^2\ 6s^2$

$14\ f e^-$ have Extremely Poor shielding
$\sigma \downarrow$ $z_{eff} \uparrow$ Contraction ↑ Size ↓



due to Similarities in Size d-Block metals are used in alloy formation.



f-Block Lanthanoids (L→R)

(M) Eu > La > Ce > Pr > Nd > Pm > Sm < Eu > Gd > Tb > Dy > Ho > Er > Tm > Yb > Lu.

- Stable Configuration
- Loose Packing :
  - Weak Metallic Bonding, Size ↑

(M^{3+}) $La^{3+} > \ldots\ldots > Lu^{3+}$

In Lanthanoids Size ↓se L→R in (M) as well as M^{3+} (Ionic Size)

due to ↑se in Zeff

↳ Reason $\bar{e}$ are filling in 4f subshell

σ↓ → Zeff ↑se (Lanthanoid Contra

QUESTION

Because of lanthanoid contraction, which of the following pairs of elements have nearly same radii? (Numbers in the brackets are atomic numbers).

[AIPMT 2015]

A Zr (40) and Nb (41)

B Zr (40) and Hf (72)

C Zr (40) and Ta (73)

D Ti (22) and Zr (40)

QUESTION

The correct order of atomic radii in group 13 elements is : [NEET-2018]

A $B < Al < In < Ga < Tl$

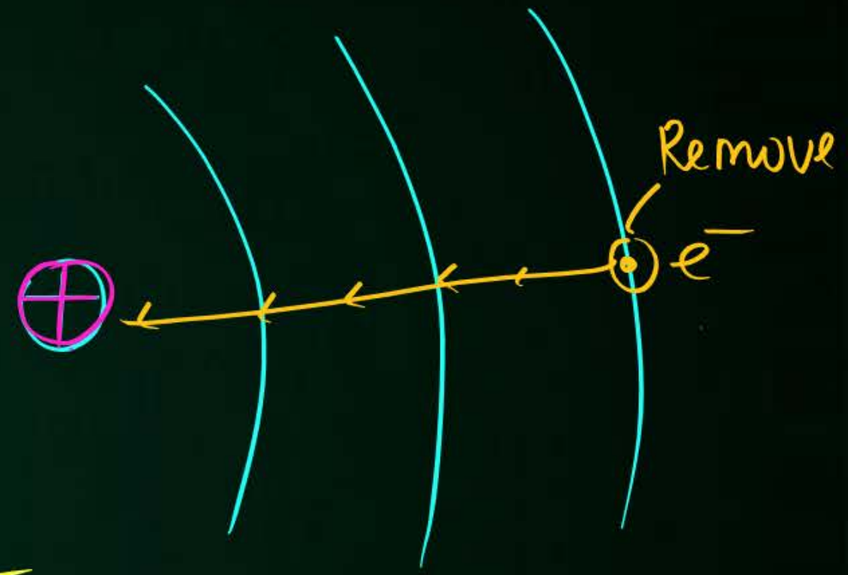
B $B < Al < Ga < In < Tl$

C $B < Ga < Al < Tl < In$

D $B < Ga < Al < In < Tl$

Ionization Energy I.E / I.P

↳ Minimum Energy required to remove most loosely bounded $\bar{e}$ From an isolated gaseous atom



↳ For Neutral atoms & Cations removal of $\bar{e}$ is always Endothermic [ΔH +ve]

$$\Delta H_i \Rightarrow +ve$$

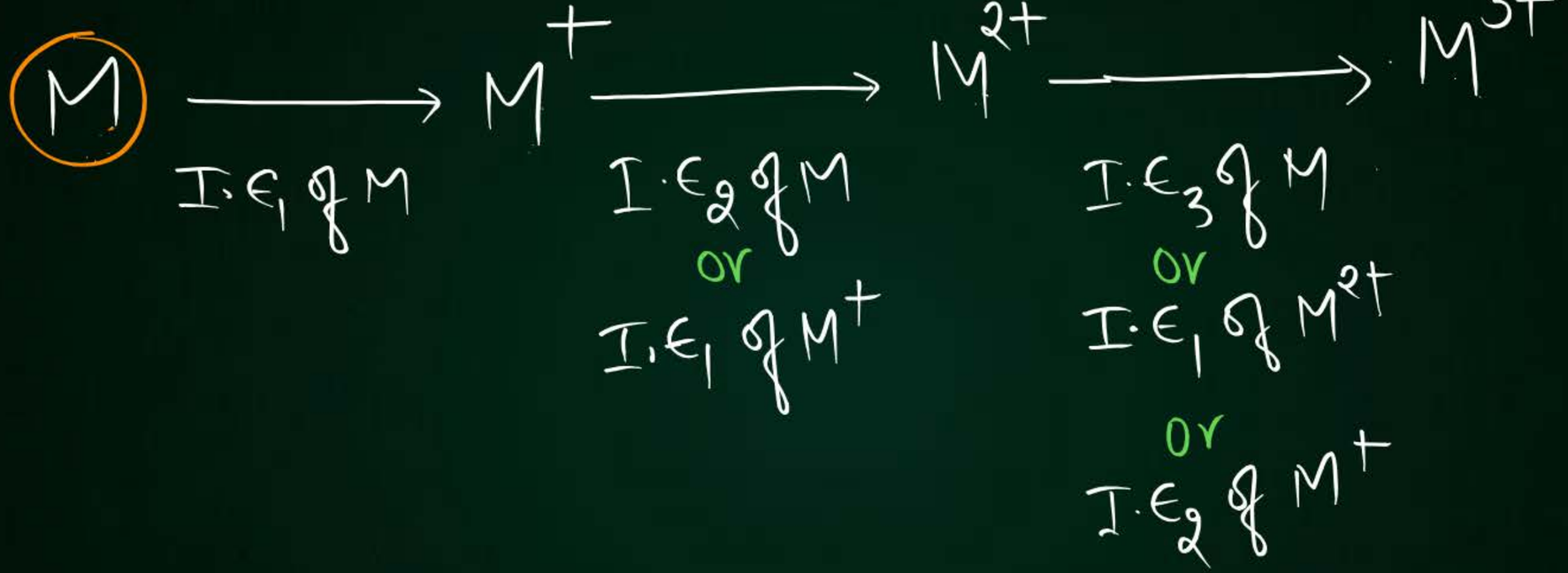
Value of Successive I.E for an Element :-

$M \xrightarrow{I.E_1} M^{+} \xrightarrow{I.E_2} M^{2+} \xrightarrow{I.E_3} M^{3+}$

$\bar{e} = p^{+}$ $\quad \bar{e} < p^{+}$ $\quad \bar{e} << p^{+}$ $\quad \bar{e} <<< p^{+}$

$Z_{eff} \uparrow_{se.} \Rightarrow$ Value of Successive I.E $\uparrow_{se.}$

$I.E_1 < I.E_2 < I.E_3 - - - - - -$


M
M+
M2+
M3+
I.E1 of M
I.E2 of M
or
I.E1 of M+
I.E3 of M
or
I.E1 of M2+
or
I.E2 of M+

QUESTION

In which of the following the energy change corresponds to first ionization potential :-

A $X_{(g)} \rightarrow X^{+}_{(g)} + e$

B $X_{2(g)} \rightarrow X^{+}_{(g)} + e$

C $X_{(s)} \rightarrow X^{+}_{(g)} + e$

D $X_{(aq)} \rightarrow X^{+}_{(aq)} + e$

QUESTION

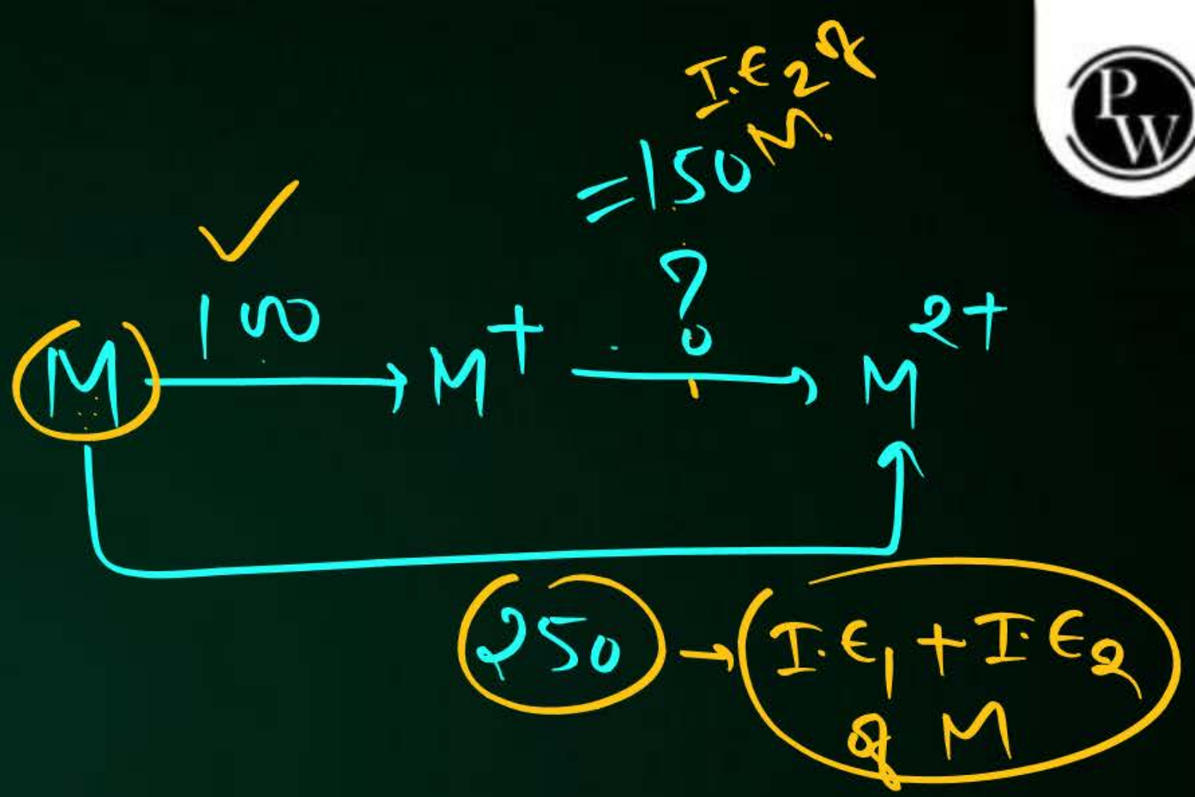
$M(g) \rightarrow M^{+}(g) + e^{-}$, $\Delta H = 100$ eV,
$M(g) \rightarrow M^{2+}(g) + 2e^{-}$, $\Delta H = 250$ eV
Which is incorrect statements :-

A IE_1 of M(g) is 100 eV ✓

B IE_2 of M(g) is 150 eV ✓

C IE_2 of M(g) is 250 eV ✗

D None



THANK YOU

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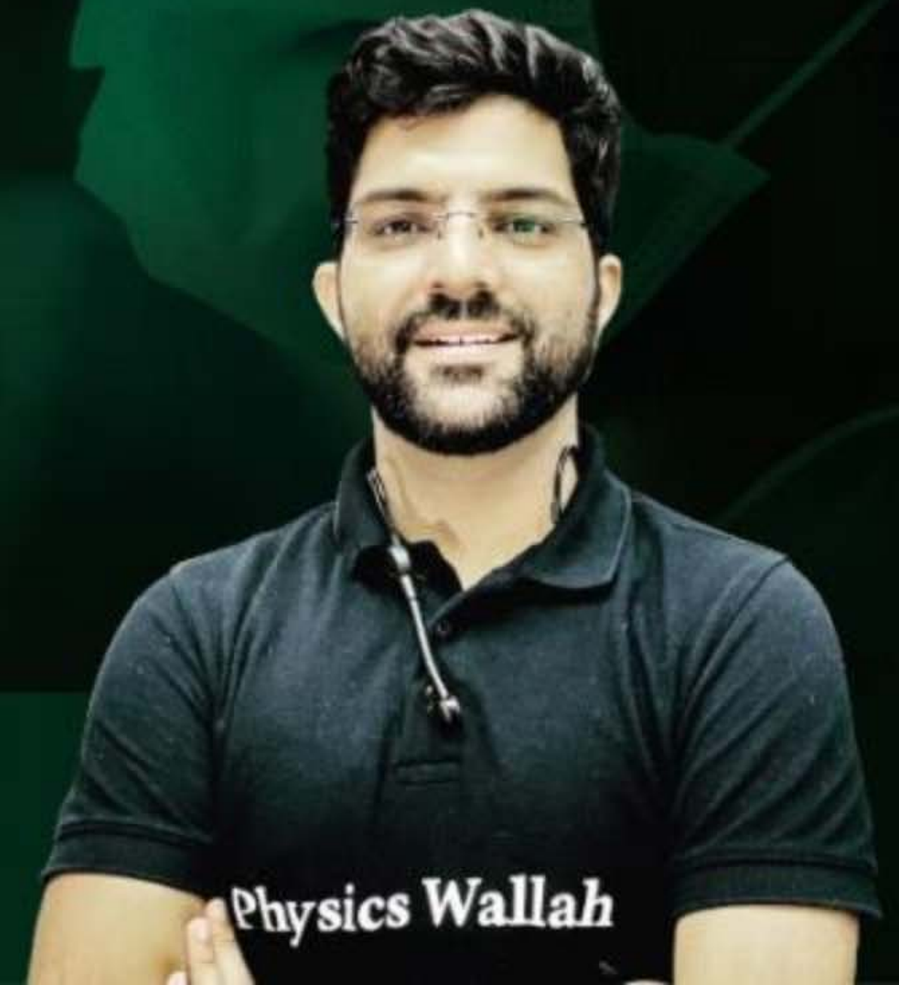
FOR NEET 2025

Lecture-07 | Inorganic Chemistry

Classification of Elements and Periodicity in Properties

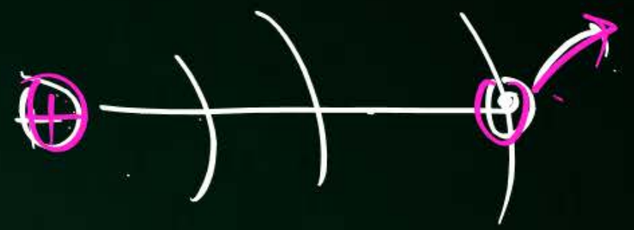


By - Mohit Dadheech (MD Sir)

Topics *to be covered*

1. Ionization Energy
   - Factors & Imp orders
   - 2nd I.E

Factors affecting I.E.



(1) Size :— $I.E \propto \frac{1}{Size}$

(2) Z_{eff} :— $I.E \propto Z_{eff}$

(3) Stable Configurations
- Fully Filled → np^6 Inert gas, Max I.E in a Period.
- Half filled → np^3 I.E ↑ more than adjacent np^4 Configuration

$np^3 > np^4$

Ex.1 $2p^3 > 2p^4$
N > O

Ex.2 $3p^3 > 3p^4$
P > S

(4) Penetration Power :—

$ns > np > nd > nf$

I.E

$ns^2 > np^1$

Be > B

$2s^2$ $2p^1$

Mg > Al

$3s^2$ > $3p$

Order of I.E

2nd Period

He ⇒ n=1, $1s^2$ ⇒ Max. I.E in P.T

Li < Be > B < C < N > O < F < Ne

Li: $2s^1$ | Be: $2s^2$ | B: $2p^1$ | C: $2p^2$ | N: $2p^3$ | O: $2p^4$ | F: $2p^5$ | Ne: $2p^6$

Be: $2s^2$, B: $2p^1$ → P.P

N: $2p^3$, O: $2p^4$ → Half filled stability

Ne: $2p^6$ → Fully Filled Max I.E

Li < B < Be < C < O < N < F < Ne

3rd Period

Na < Mg > Al < Si < P > S < Cl < Ar

Na: $3s^1$ | Mg: $3s^2$ | Al: $3p^1$ | Si: $3p^2$ | P: $3p^3$ | S: $3p^4$ | Cl: $3p^5$ | Ar: $3p^6$

Mg: $3s^2$, Al: $3p^1$ → P.P

P: $3p^3$, S: $3p^4$ → Half filled.

→ Na < Al < Mg < Si < S < P < Cl < Ar

For n^{th} period

$(n = 2/3)$

MDJ

$ns^2 > np^1$

$ns^1 < np^1 < ns^2 < np^2 < np^4 < np^3 < np^5 < np^6$

$np^1 < ns^2$: P.P.

$np^4 < np^3$: Half filled

QUESTION

If the graph is plotted between atomic numbers and ionisation potential. Which group of element occupy the lowest position on the curve :–

A Alkaline earth metal

B Inert gas

C Actinides

D Alkali metals

ns¹

QUESTION

IP is influenced by -

$Z_{eff} \propto \frac{1}{\sigma}$

A Size of atom

B Effective nuclear charge

$Z_{eff} \propto I.E$

$I.E \propto \frac{1}{\sigma}$

C Electrons present in inner shell (σ)

D All

How to write $I.E_2$ order

$I.E_1 \rightarrow$ 1^{st} e^- removal process

$I.E_2 \longrightarrow$ 2^{nd} e^- removal process (1^{st} Nikal Chuka Hai)

$I.E_2$ of C = 2^{nd} e^- removal

$$C \xrightarrow[I.E_1 \text{ of } C]{} C^+ \xrightarrow[\text{or } I.E_1 \text{ of } C^+]{I.E_2 \text{ of } C} C^{2+}$$

Same

C^+ $2p^1$ < N^+ $2p^2$ ($I.E_1$)

or

C $2p^2$ $2p^1$ < N $3p^3$ $2p^2$ ($I.E_2$)

Ex-1

$O < F$ $(I.E_1)$

$2p^4$ $2p^5$

$O > F$ $(I.E_2)$

~~$2p^4$~~ ~~$2p^5$~~

$2p^3 > 2p^4$

Halffilled

Ex. 2 C N O F $(I.E_2)$

~~$2p^2$~~ ~~$2p^3$~~ ~~$2p^4$~~ ~~$2p^5$~~

$2p^1$ $2p^2$ $2p^3$ $2p^4$

$C < N < F < O$

Ex.3 Na Mg Al Si ($I.E_2$)

$2p^6$ ~~$3s^1$~~ ~~$3s^2$~~ ~~$3p^1$~~ ~~$3p^2$~~

$2p^6$ $3s^1$ $3s^2$ $3p^1$ $\Rightarrow$ $3s^1 < 3p^1 < 3s^2 < 2p^6$

pp

Max ∵ Full filled

$-n=2$

Size ↓

$Mg < Si < Al < Na$

I.E order in Isoelectronic Series & Ions of same element

Isoelectronic Species :-

N^{3-} O^{2-} F^- Na^+ Mg^{2+} Al^{3+} →

Z_{eff} ↑ I.E ↑

Ions of same element

O^{2+} O^+ O O^- O^{2-} →

Z_{eff} ↓ I.E ↓

Ex.

$Cl > Cl^-$ (I.E)

$3p^5 \quad 3p^6$

$3p^5 < 3p^6$ Not valid

For Same element Ions

Consider charge & Z_{eff} only

$Ne < Ne^+$ (I.E)

$2p^6 \quad 2p^5$

$2p^6 > 2p^5$

QUESTION

Which of the following has 2^{nd} IP < I^{st} IP

A Mg

B Ne

C C

D None

$M \xrightarrow{\varepsilon_1} M^{+} \xrightarrow{\varepsilon_2} M^{2+} \xrightarrow{\varepsilon_3} M^{3+}$

$\varepsilon_1 < \varepsilon_2 < \varepsilon_3 - - -$

QUESTION

The second ionization potentials in electron volts of oxygen and fluorine atoms are respectively given by :-

A 35.1, 38.3

B 38.3, 38.3

C 38.3, 35.1

D 35.1, 35.1

$O < F \quad (I.E_1)$

But

$I.E_2 \Rightarrow \quad O > F$

QUESTION

Which of the following electronic configuration an atom has the lowest ionization enthalpy ?

[AIPMT 2007]

A $1s^2\ 2s^2\ 2p^3$

B $1s^2\ 2s^2\ 2p^6\ 3s^1$ Lowest

C $1s^2\ 2s^2\ 2p^6$

D $1s^2\ 2s^2\ 2p^5$

QUESTION

Amongst the elements with following electronic configurations, which one of them may have the highest ionization energy ? **[AIPMT 2009]**

A $Ne[3s^2 3p^1]$

B $Ne[3s^2 3p^3]$

C $Ne[3s^2 3p^2]$

D $Ar[3d^{10} 4s^2 4p^3]$

Lowest

QUESTION

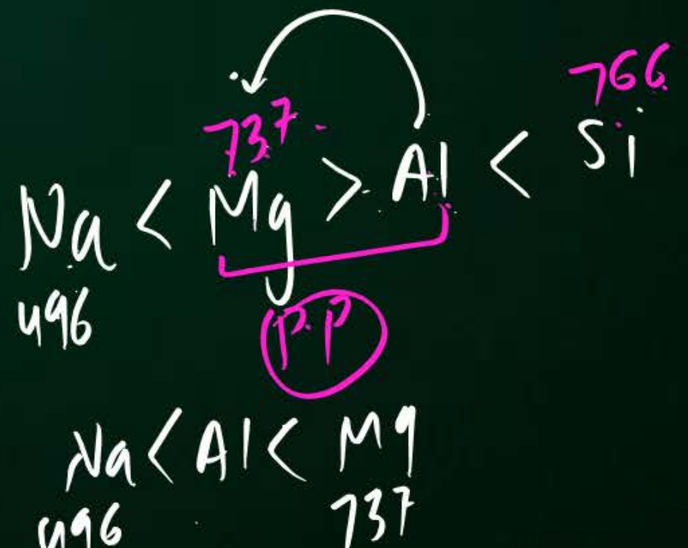
The 1st Ionization enthalpy of Na, Mg and Si are 496, 737, 766 kJ mol^{-1} respectively then what will be the 1st ionization enthalpy of Al in kJ mol^{-1} : **[AIIMS 2013]**

A. > 766 kJ mol^{-1}

B. > 496 and < 737 kJ mol^{-1}

C. > 737 and < 766 kJ mol^{-1}

D. 496 kJ mol^{-1}



QUESTION

For the second period elements the correct increasing order of first ionization enthalpy is : [NEET-2018]

A Li < Be < B < C < N < O < F < Ne

B Li < B < Be < C < O < N < F < Ne

C Li < B < Be < C < N < O < F < Ne

D Li < Be < B < C < O < N < F < Ne

QUESTION

The first ionization enthalpies of Na, Mg, Al and Si are in the order :

(H.W)

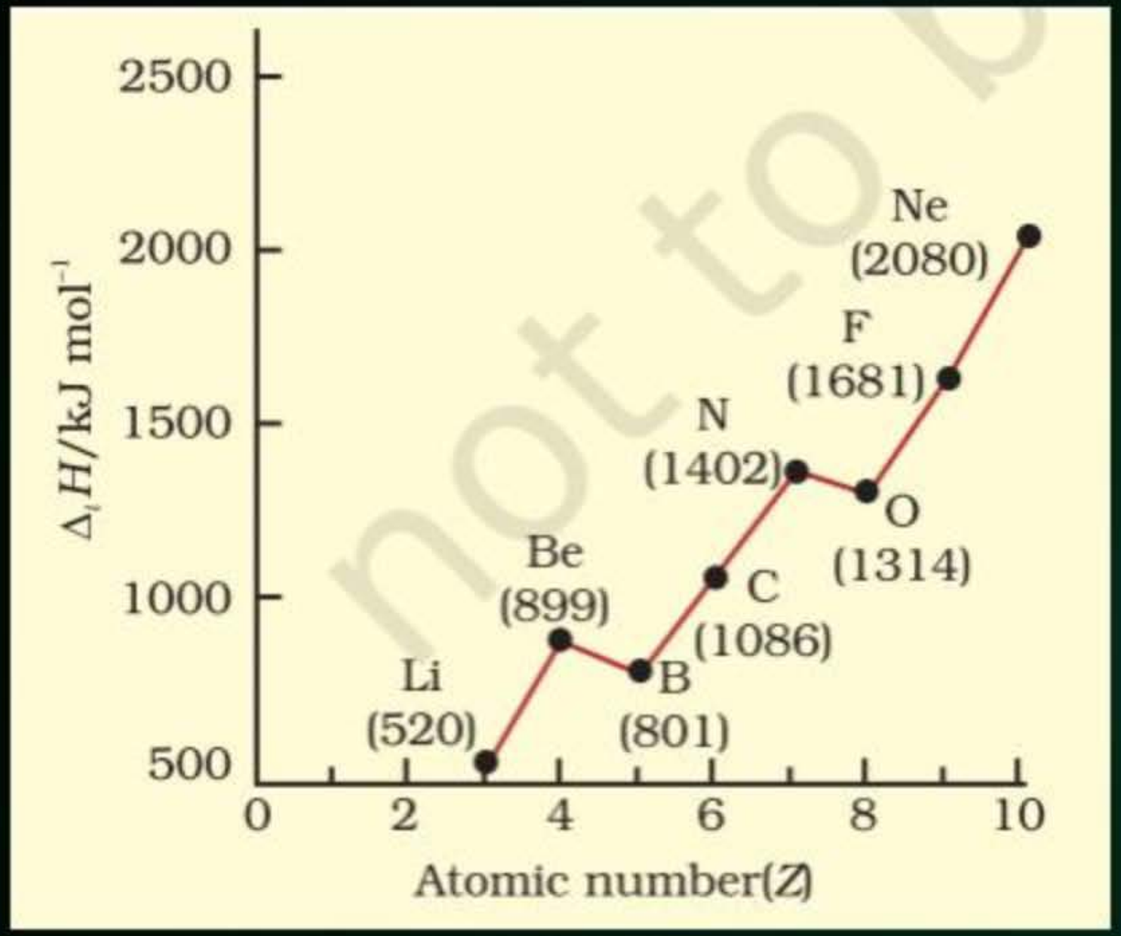
A $Na < Mg < Si < Al$

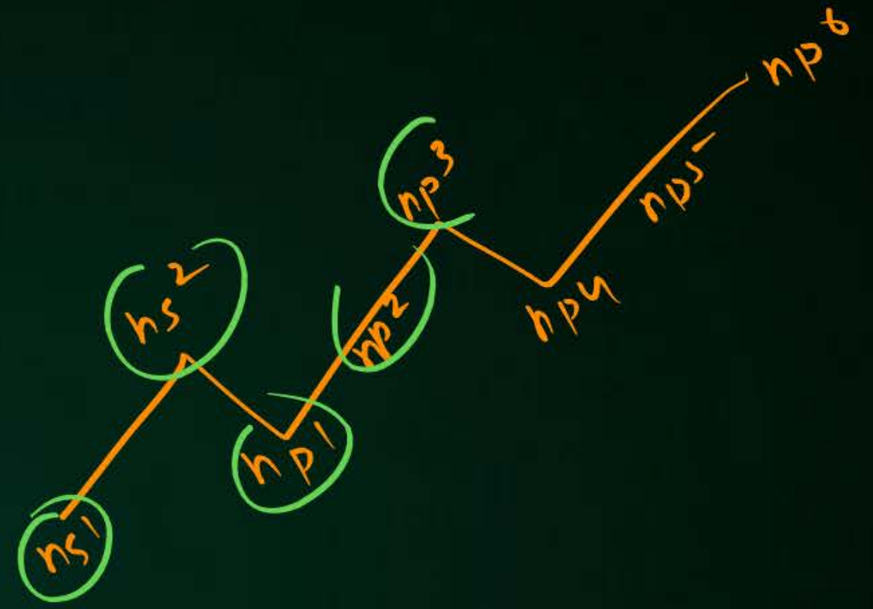
B $Na > Mg > Al > Si$

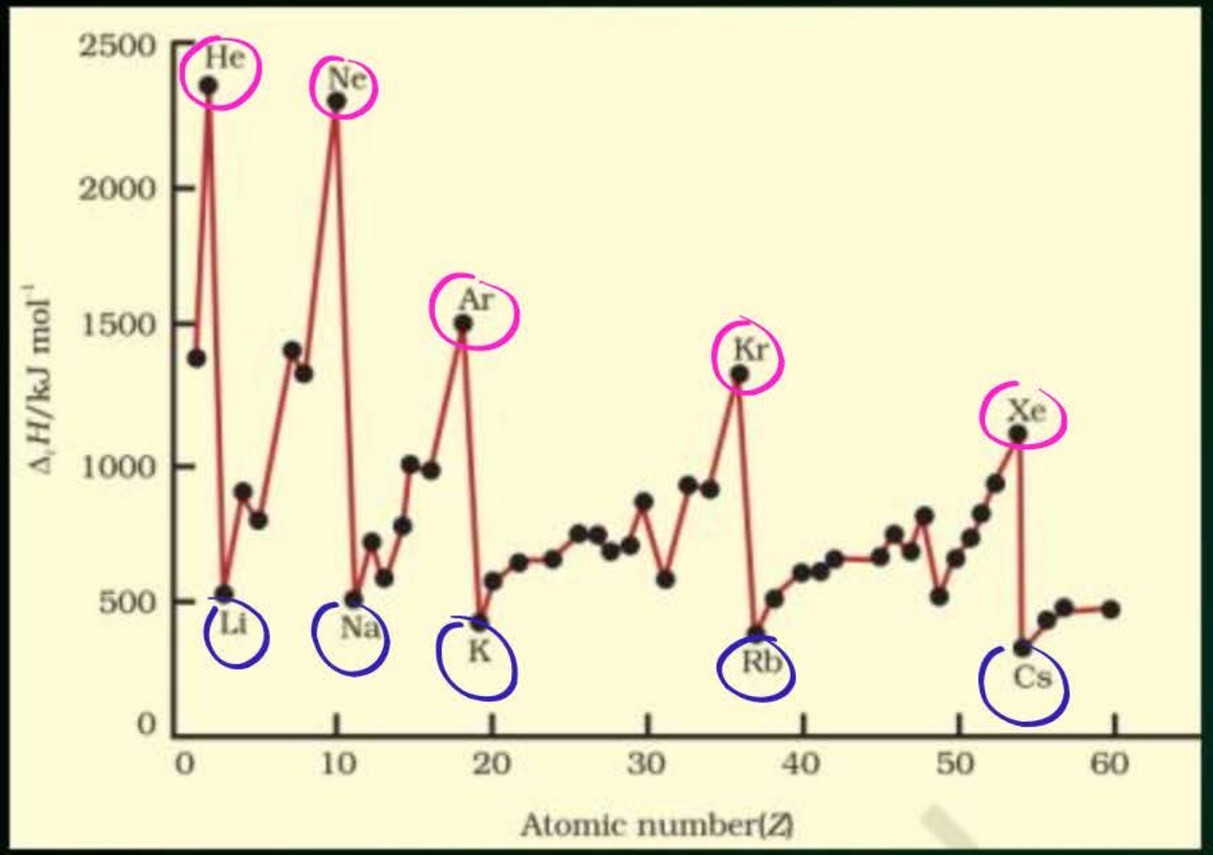
C $Na < Al < Mg < Si$

D $Na > Al > Mg > Si$

NCERT KI CHOTI CHOTI MAGAR MOTI BAATEIN

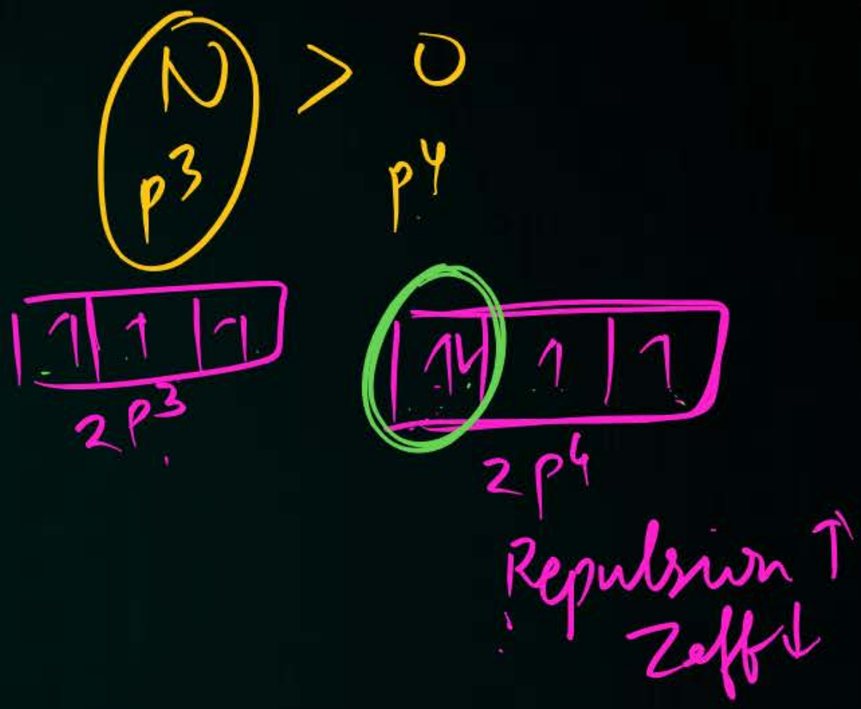

2500
2000
1500
1000
500
$\Delta_i H$/kJ mol^{-1}
0
2
4
6
8
10
Atomic number(Z)
Li
(520)
Be
(899)
B
(801)
C
(1086)
N
(1402)
O
(1314)
F
(1681)
Ne
(2080)





The periodicity of the graph is quite striking. You will find maxima at the noble gases which have closed electron shells and very stable electron configurations. On the other hand, minima occur at the alkali metals and their low ionization enthalpies can be correlated with their high reactivity.

The first ionization enthalpy of boron (Z = 5) is slightly less than that of beryllium (Z = 4) even though the former has a greater nuclear charge. When we consider the same principal quantum level, an s-electron is attracted to the nucleus more than a p-electron. In beryllium, the electron removed during the ionization is an s-electron whereas the electron removed during ionization of boron is a p-electron. The penetration of a 2s-electron to the nucleus is more than that of a 2p-electron; hence the 2p electron of boron is more shielded from the nucleus by the inner core of electrons than the 2s electrons of beryllium. Therefore, it is easier to remove the 2p-electron from boron compared to the removal of a 2s- electron from beryllium. Thus, boron has a smaller first ionization enthalpy than beryllium. Another "anomaly" is the smaller first ionization enthalpy of oxygen compared to nitrogen. This arises because in the nitrogen atom, three 2p-electrons reside in different atomic orbitals (Hund's rule) whereas in the oxygen atom, two of the four 2p electrons must occupy the same 2p-orbital resulting in an increased electron-electron repulsion. Consequently, it is easier to remove the fourth 2p-electron from oxygen than it is, to remove one of the three 2p-electrons from nitrogen.


N
p3
> 0
p4
2p3
2p4
Repulsion ↑
Zeff ↓

THANK YOU

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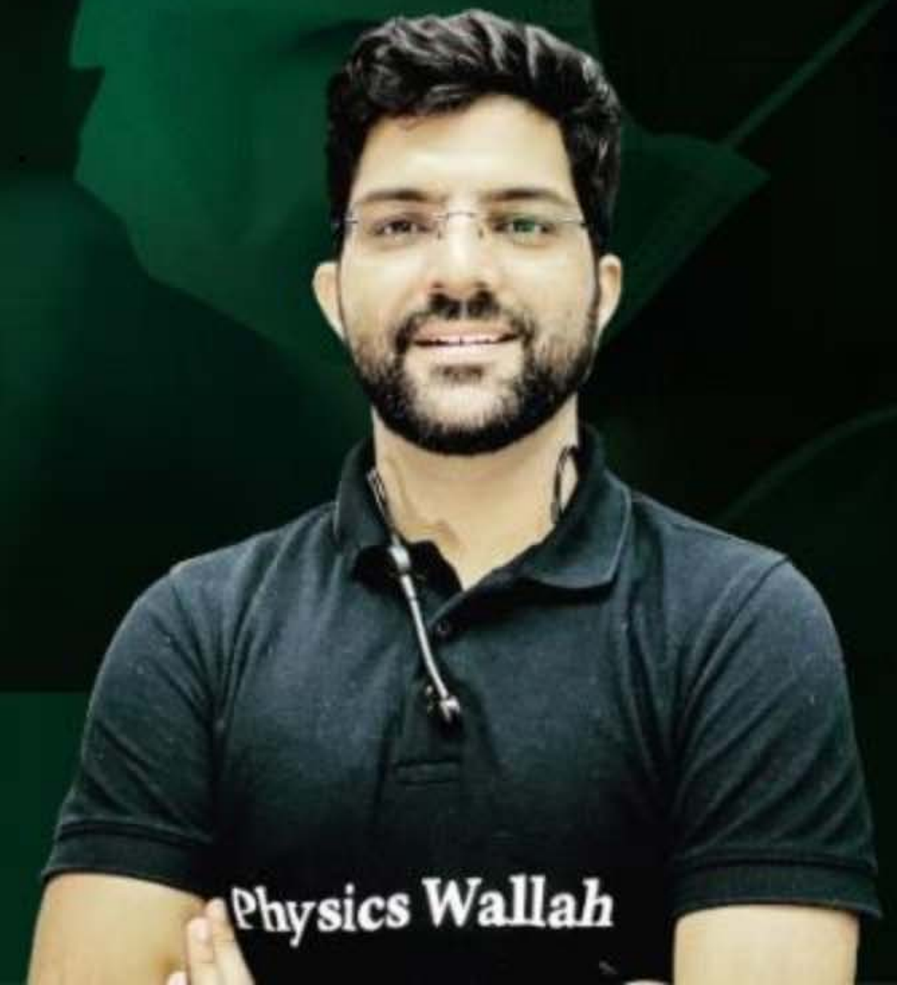
FOR NEET 2025

Lecture- 08 | Inorganic Chemistry

Classification of Elements and Periodicity in Properties

By - Mohit Dadheech (MD Sir)



Topics *to be covered*

1. Applications of I.E.
2. Blockwise Ionization Energy
3. Electrongain Enthalpy

Applications of I.E.

(1) Reactivity of Metals :-

I.E ↓ Reactivity ↑se

Electropositive

Tendency to loose e^-

Li
Na
K
Rb
Cs

n ↑ Size ↑
I.E ↓
Reactivity ↑se

Imp (2) Prediction of Valence e^- & Possible Oxidation state:-

(M)

$I.E_1$	$I.E_2$	$I.E_3$	$I.E_4$
50	78	325	415

Largest Jump Between $I.E_2$ & $I.E_3$

Valence shell $e^- \Rightarrow 2$

Possible O.S $\longrightarrow +2$ (M^{2+})

Formula of It's

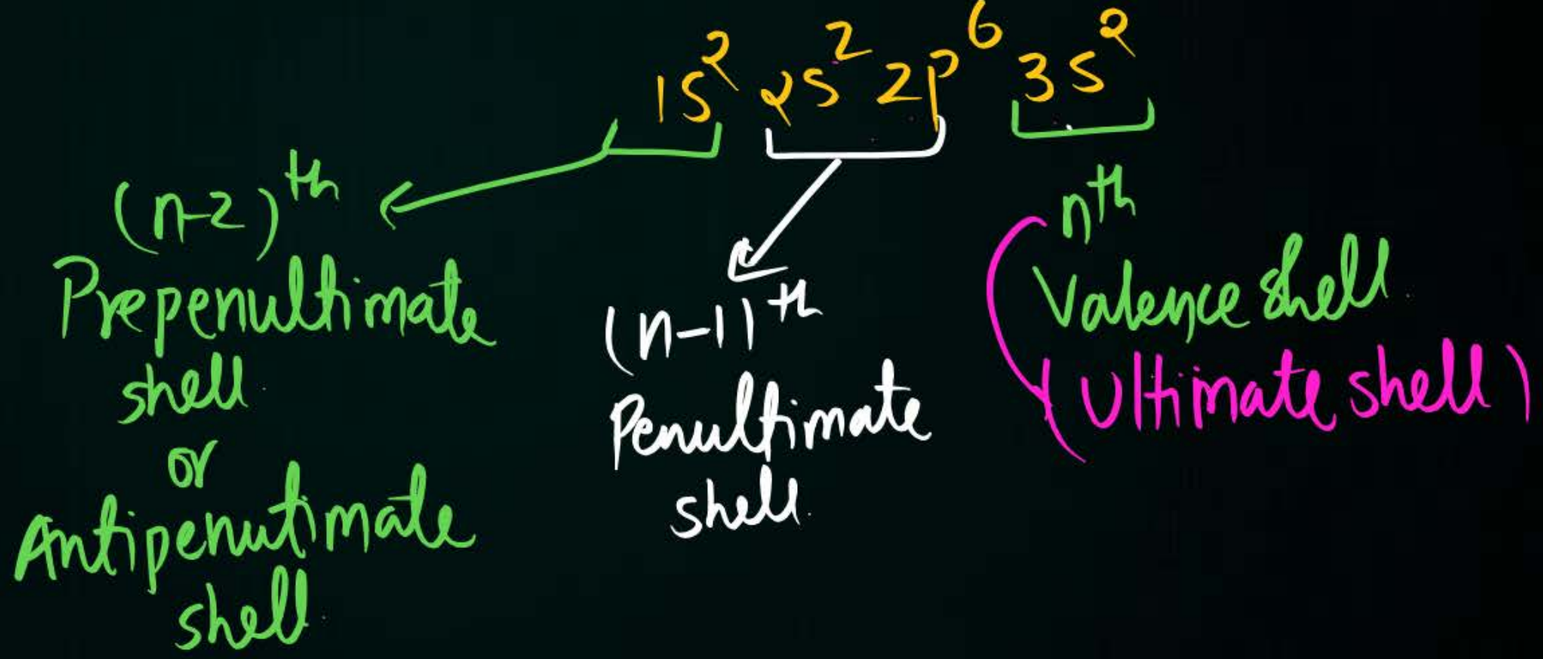
M^{2+}

Carbonate	CO_3^{2-}	M^{2+}	MCO_3
Nitride	N^{3-}	M^{2+}	M_3N_2
Nitrate	NO_3^-	M^{2+}	$M(NO_3)_2$
Oxide	O^{2-}	M^{2+}	MO
chloride	Cl^-	M^{2+}	MCl_2
Sulphite	SO_3^{2-}	M^{2+}	MSO_3
Sulphate	SO_4^{2-}	M^{2+}	MSO_4

Valence shell

↓

gen. Outer most shell



QUESTION

IE_1 IE_2 IE_3

Valence e^-

A sudden large jump between the values of 2nd and 3rd IP of an element would be associated with the electronic configuration :-

A $1s^2, 2s^2\ 2p^6, 3s^1$ Valence e^- = 1

B $1s^2, 2s^2\ 2p^6, 3s^2\ 3p^5$ (7)

C $1s^2, 2s^2\ 2p^6, 3s^2\ 3p^2$ (4)

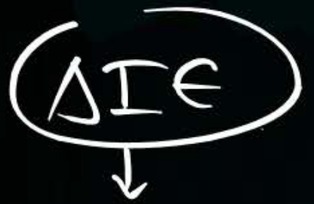
D $1s^2, 2s^2\ 2p^6\ 3s^2$ (2)

group No - (2)

Alkaline earth Metal.

Val e^- = 2

③ Stability of Oxidation states (Only for S-Block)
(Lower & Higher)



difference b/w two successive I.E

(1) if $\Delta IE \leq 11eV$ → Higher O.S will be stable

(2) If $\Delta IE \geq 16eV$ → Lower O.S will be stable

$Na \xrightarrow[10\ eV]{-e^-} Na^+ \xrightarrow[70\ eV]{-e^-} Na^{2+}$

$1s^2 2s^2 2p^6 3s^1$

IE_1 IE_2

Na^+ → $2p^6$

$\Delta IE = 60$

L.O.S will be stable

Na^+ ✓

Na^{2+} ✗✗

$Mg \xrightarrow[15eV]{IE_1} Mg^{+} \xrightarrow[22\ eV]{IE_2} Mg^{2+}$

$\Delta IE \leq 11eV$

$\Delta IE = 7eV$

H.O.S will be more stable

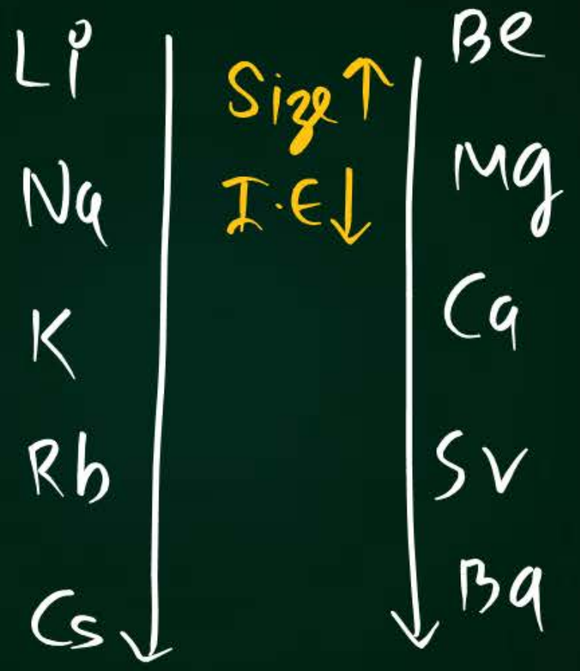
Mg^{+} ✗

Mg^{2+} ✓

Blockwise Ionization Energy

Top to bottom

S- Block



L→R

$I.E_1$ AM < AEM

$ns^1 < ns^2$

But $I.E_2$ AM > AEM

∵ because after removal of 1^{st} e^- AM achives Fully Filled stable Configuration

Ex $Na < Mg$ $(I.E_1)$

Na $1s^2 2s^2 2p^6 3s^1$ $\quad$ Mg $3s^2$

Na $1s^2 2s^2 2p^6 3s^1$ > Mg $3s^2$ $3s^1$

p-Block

Top → Bottom

Imp

13th — 14th — 15th — 18th

No exception → (T → B I.E ↓)

B
Al
Ga
In
Tl
(8)

C
Si
Ge
Sn
Pb
(8)

T.C
due to poor σ of 3d e⁻
Zeff ↑ so I.E ↑

due to poor σ of 4f e⁻ Zeff ↑ I.E ↑ (L.C)

Final orders

13th B > Tl > Ga > Al > In.

Beet Gai

14th C > Si > Ge > Pb > Sn

d-Block

(L→R) 3d series :-

Vinita thi Nahi Kon

Sc < V < Cr < Ti < Mn < Ni < Cu < Co < Fe < Zn

Suno Kamal Mani Kyu Fir Jane.

Imp Points

* I.E$_2$ of elements ↑se L→R (Generally)
* I.E$_1$ For First member of each series is min & Last member have max I.E.

3d Sc$_{min}$ - - - Zn max

4d Y$_{min}$ - - - Cd max

5d La$_{min}$ - - - Hg max

Imp. Orders

$Cr < Mn$ $(I.E_1)$

$Cr > Mn$ $(I.E_2)$

Cr: $3d^5 4s^1$ $\quad$ Mn: $3d^5 4s^2$

$3d^5$ $\quad$ $4s^1$

Half filled stable

$Cu < Zn$ $(I.E_1)$

$Cu > Zn$ $(I.E_2)$

Cu: $3d^{10} 4s^1$ $\quad$ Zn: $3d^{10} 4s^2$

$3d^{10}$ $\quad$ $4s^1$

Fully filled stable

QUESTION

* $I.E_2$ generally $L \to R$

The correct order of decreasing second ionization enthalpy of Ti(22), V(23), Cr(24) and Mn(25) is : [AIPMT 2008]

* $Cr > Mn$ ($I.E_2$)

A. Mn > Cr > Ti > V

B. Ti > V > Cr > Mn

C. Cr > Mn > V > Ti

D. V > Mn > Cr > T

$Mn < Fe \quad (IE_1)$

$Mn < Fe \quad (IE_2)$

$Mn > Fe \quad (IE_3)$

$3d^5 4s^2$ $\quad$ $3d^6 4s^2$

$3d^5$ $\quad$ $3d^6$

Half filled

QUESTION

Four successive members of the first row transition elements are listed below with their atomic numbers. Which one of them is expected to have the highest third ionization enthalpy :- [AIPMT 2005]

A Vanadium (Z = 23

B Manganese (Z = 25)

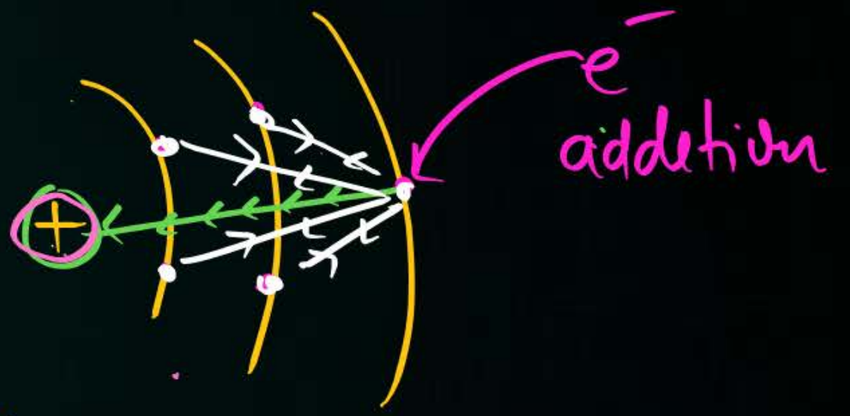
C Chromium (Z = 24)

D Iron (Z = 26)

Electron gain Enthalpy (ΔH_{eg})

* Addition of e^-

↳ Overall change in Energy during the addition of $\bar{e}$ into an isolated gaseous atom.



If R > A
then ΔH_{eg} +ve
Endothermic

Repulsion Energy ↑se
Attraction Energy ↓

If A > R ⇒ ΔH_{eg} -ve
Exo.

Relation b/w EA & ΔH_{eg}

EA
(Neeyat)

EA Positive

↓

ē ko bulane/Neeyat Jyada → ΔH_{eg} -ve Exothermic

EA Negative
EA Zero → ΔH_{eg} +ve Endothermic

ΔH_{eg} Electron gain Enthalpy
Energy Measurement

Electron Gain Enthalpy

When an electron is added to a neutral gaseous atom (X) to convert it into a negative ion, the enthalpy change accompanying the process is defined as the Electron Gain Enthalpy ($\Delta_{eg}H$).

Electron affinity (E.A) :
Tendency to gain electron.

→ ΔH_{eg} → Measurement of tendency in terms of Energy.

Electron gain enthalpy (ΔH_{eg}):

- Electron affinity is measured in terms of electron gain enthalpy.
- For neutral element ΔH_{eg} is exothermic **except N, Alkaline earth metals and inert gases.** (Be & Mg)
- ΔH_{eg} of cation is always exothermic.
- ΔH_{eg} of anion is always endothermic (formation of poly negative anions).

Exothermic/Endothermic Process :

* Addition of e^- in Cation → Always Exo.
* Addition of e^- in anion
  or
  Formation of Polynegative anion.

→ Always Endothermic.
∵ due to more Repulsion (Interelectronic Repulsion)

* Addition of e in N, Be, Mg and Inertgases → Endothermic

$Cl + e^- \longrightarrow Cl^-$ Exo

$F + e^- \longrightarrow F^-$ Exo

$N + e^- \longrightarrow N^-$ Endo

$Be + e^- \longrightarrow Be^-$ Endo

I.E $O \longrightarrow O^+ + e^-$ (Endo)

$O + 2e^- \longrightarrow O^{2-}$ (Endo)

$O^- + e^- \longrightarrow O^{2-}$ (Endo)

$S + 2e^- \longrightarrow S^{2-}$ (Endo)

$Na^+ + e^- \longrightarrow Na$ (Exo)

$Ne + e^- \longrightarrow Ne^-$ (Endo)

$Xe \longrightarrow Xe^+ + e^-$ (Endo)

Step-I $O + e^- \longrightarrow O^-$ (Exo) -150 ΔH_{eg} -ve

Step-II $O^- + e^- \longrightarrow O^{2-}$ (Endo) $+800$ ΔH_{eg} +ve.

$O + 2e^- \longrightarrow O^{2-}$ (Endo) $\rightarrow$ $+800 - 150$

$= +650$ Endo

Step-II $\rightarrow$ due to rise in Inter electronic repulsion

ΔH_{eg} +ve.

QUESTION

$O_{(g)} + 2e^- \rightarrow O^{2-}_{(g)}$ $\Delta H_{eg} = 744.7$ KJ/mole.

The positive value of ΔH_{eg} is due to :-

A. Energy is released to add on 1 e^- to O^{-1}

B. Energy is required to add on 1 e^- to O^{-1}

C. Energy is needed to add on $1e^-$ to O

D. None of the above is correct

QUESTION

Electron addition would be easier in :-

A O

B O^{+}

C O^{-}

D O^{+2}

QUESTION

The process requiring the absorption of energy is. (Endo)

A $F \rightarrow F^-$ ✗

B $Cl \rightarrow Cl^-$ ✗

C $O \rightarrow O^{2-}$ ✓

D $H \rightarrow H^-$ ✗

Homework

From Module

Questions based on Size & I.E

THANK YOU

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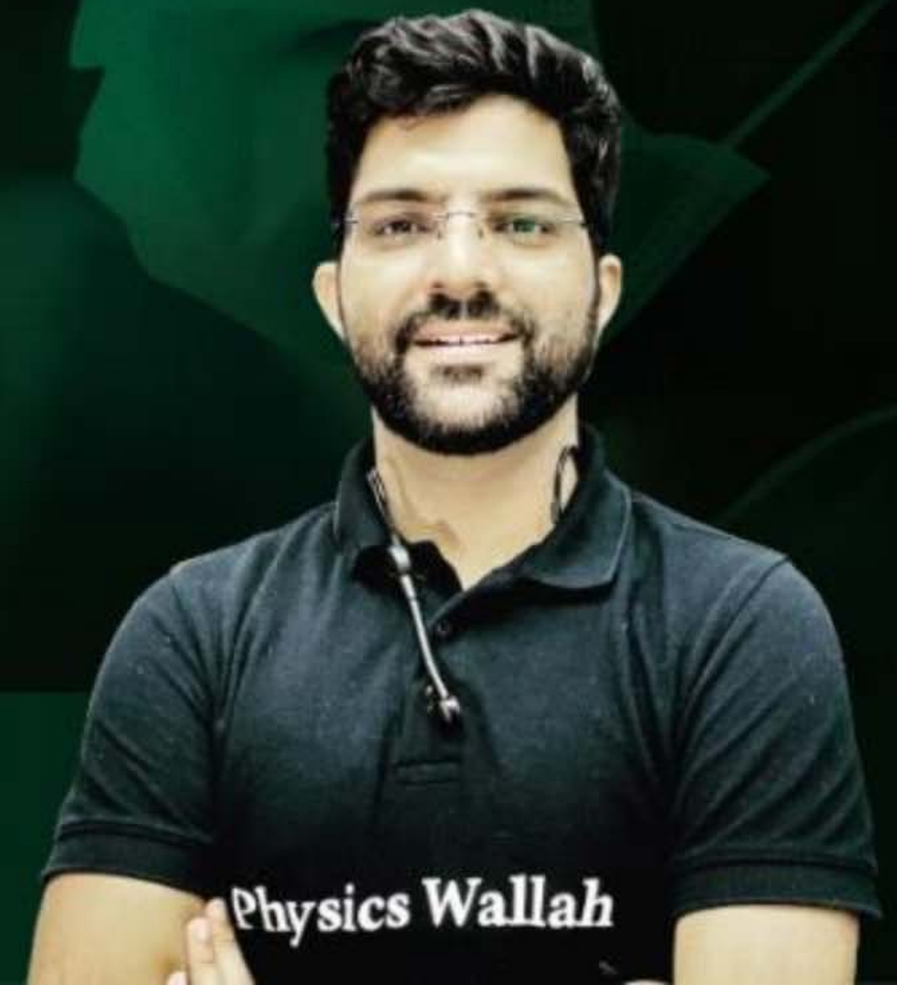
FOR NEET 2025

Lecture- 09 | Inorganic Chemistry

Classification of Elements and Periodicity in Properties

By - Mohit Dadheech (MD Sir)



Topics *to be covered*

1. Factors affecting EA & Imp Orders
2. Electronegativity (EN)
3.

Factors affecting EA :-

1. Size — Size ↓ EA ↑

2. Zeff — Zeff ↑ EA ↑

3. Stable Configuration
   - → Fully Filled np^6 — min EA in a period
   - → Half Filled
     - $np^2 > np^3$
     - $C > N$
     - Ex $2p^2$ $2p^3$
     - $3p^2$ $3p^3$
     - $Si > P$

4. Penetration Power → $ns^1 > np^1$
   - $Li > B$
   - $Na > Al$

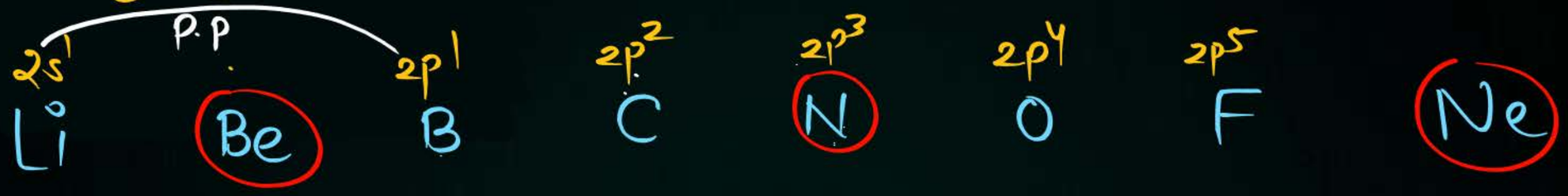
Zero EA or +ve Δ Heg

↑ Inert gas

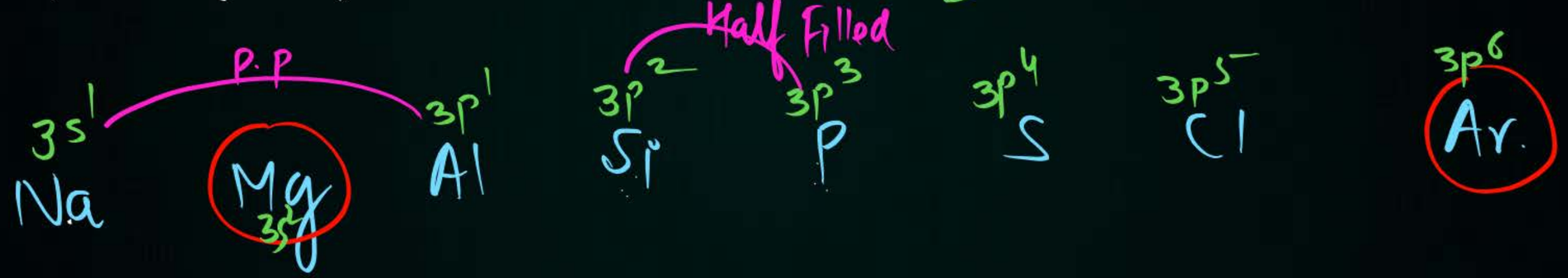
IE
- $np^3 > np^4$

P.P
- $ns^2 > np^1$

EA order of 2nd & 3rd Period :-



Ne < Be < N < B < Li < C < O < F



Ar < Mg < Al < Na < P < Si < S < Cl

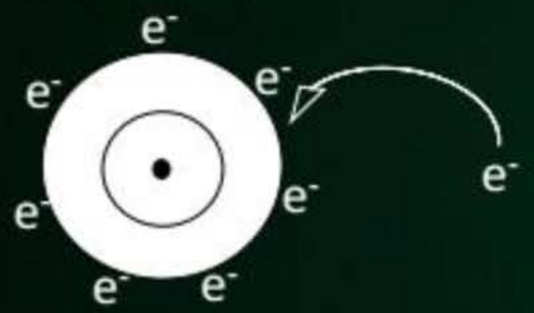
In Some p-Block Elements.

Why the EA of 3rd period elements is more than EA of 2nd period elements ?

F

[He] $2s^2 2p^5$

2nd Period

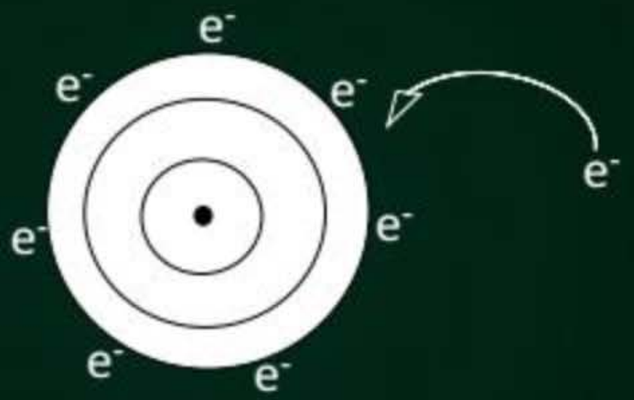


- Small size
- High surface e^- density
- More repulsion for upcoming e^-
- Less attraction for new e^-
- Less EA (Less –ve value of $\Delta_{eg}H$)

Cl

[Ne] $3s^2 3p^5$

3rd Period



- Large size
- Low surface e^- density
- Less repulsion for upcoming e^-
- More attraction for new e^-
- More EA (More –ve value of $\Delta_{eg}H$)

2nd Period	B	C	N	O	F
3rd Period	Al	Si	P	S	Cl

(Same reason)

Imp orders :-

Halogen Family: F < Cl > Br > I

Cl > F > Br > I

Oxygen Family: O < S > Se > Te > Po

S > Se > Te > Po > O

Most Imp For NEET

Halogen has max $\in A$ in a period.

Max $\in A$ in PT $\Rightarrow$ Cl

QUESTION

Arrange the following in increasing order of electron affinity :

O, S, F, Cl

O < S < F < Cl Imp PYQ

Na, Si, P, S

Na (s^1) Si (p^2) P (p^3) S (p^4) ⇒ Na < P < Si < S

F, Cl, Br, I

I < Br < F < Cl

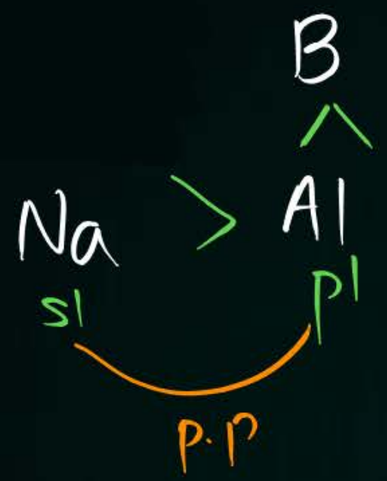
Li, Be, B, C

Li (s^1) Be (s^2) B (p^1) C (p^2)

p·p

Be < B < Li < C

Na B Al



B < Al < Na

QUESTION

For electron affinity of halogens which of the following is correct :

A. Br > F ✗

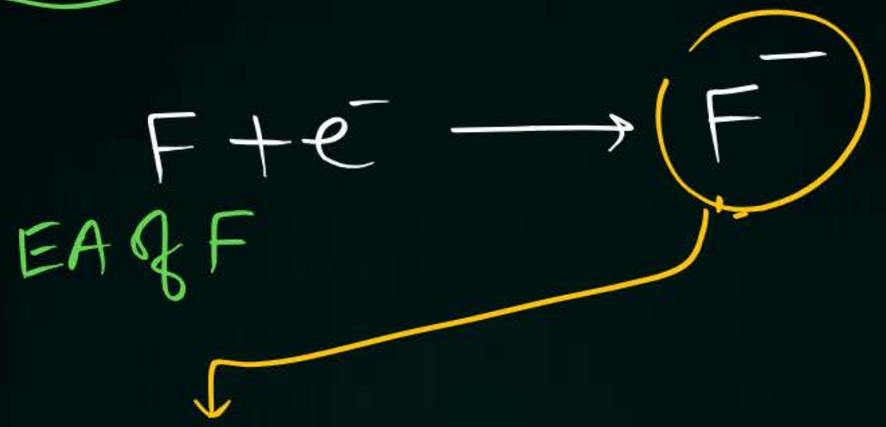
B. F > Cl ✗

C. Br > Cl ✗

D. F > I ✓

Cl > F > Br > I

Relation b/w I.E & E.A :-



$$|E.A \text{ of } F| = |I.E \text{ of } F^-|$$

① $|EA| = |I \cdot E|^{-1}$ (T)

② $|EA| = |I \cdot E|$ (F)

③ $|EA|^{T} = |I \cdot E|$ (T)

QUESTION

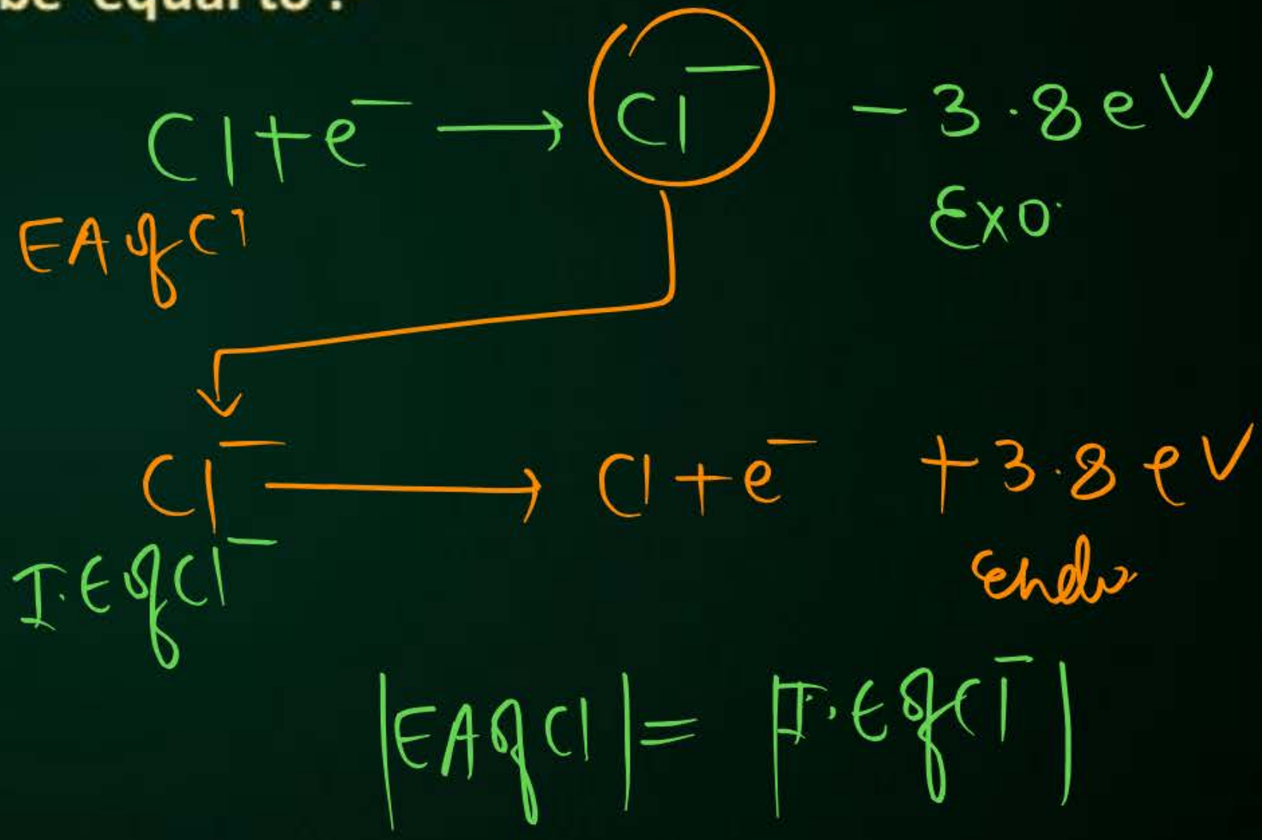
In the formation of a chloride ion, from an isolated gaseous chlorine atom, 3.8 eV energy is released, which would be equal to :-

A Electron affinity of Cl^-

B Ionisation potential of Cl

C Electronegativity of Cl

D Ionisation potential of Cl^-



QUESTION

Process $Na^+ \xrightarrow{I} Na_{(g)} \xrightarrow{II} Na_{(s)}$

$Na^+ + e^- \longrightarrow Na_{(g)}$ (Exo)

$Na_{(g)} \downarrow$

$Na_{(s)}$ (Exo)

A. In (I) energy released, (II) energy absorbed

B. In both (I) and (II) energy is absorbed

C. In both (I) and (II) energy is released ✓

D. In (I) energy absorbed, (II) energy released

QUESTION

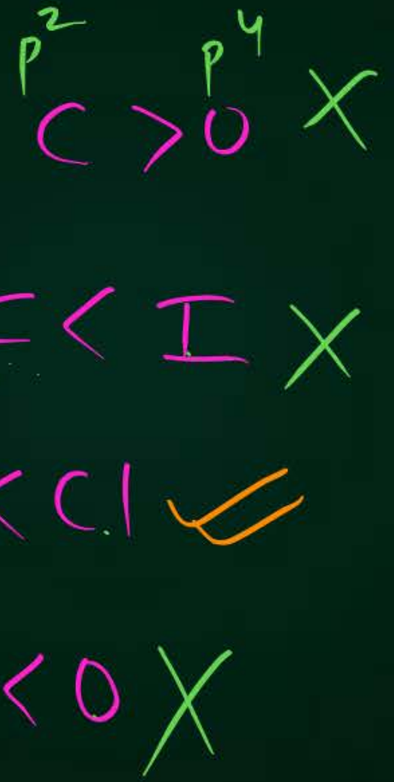
The electron affinity

A. Of carbon is greater than oxygen

B. Of fluorine is less than iodine

C. Of F is less than Cl

D. Of S is less than oxygen



QUESTION

Which of the following electronic configuration is expected to have highest electron affinity:-

A $2s^2\ 2p^0$

B $2s^2\ 2p^2$

C $2s^2\ 2p^3$

D $2s^2\ 2p^1$

THANK YOU

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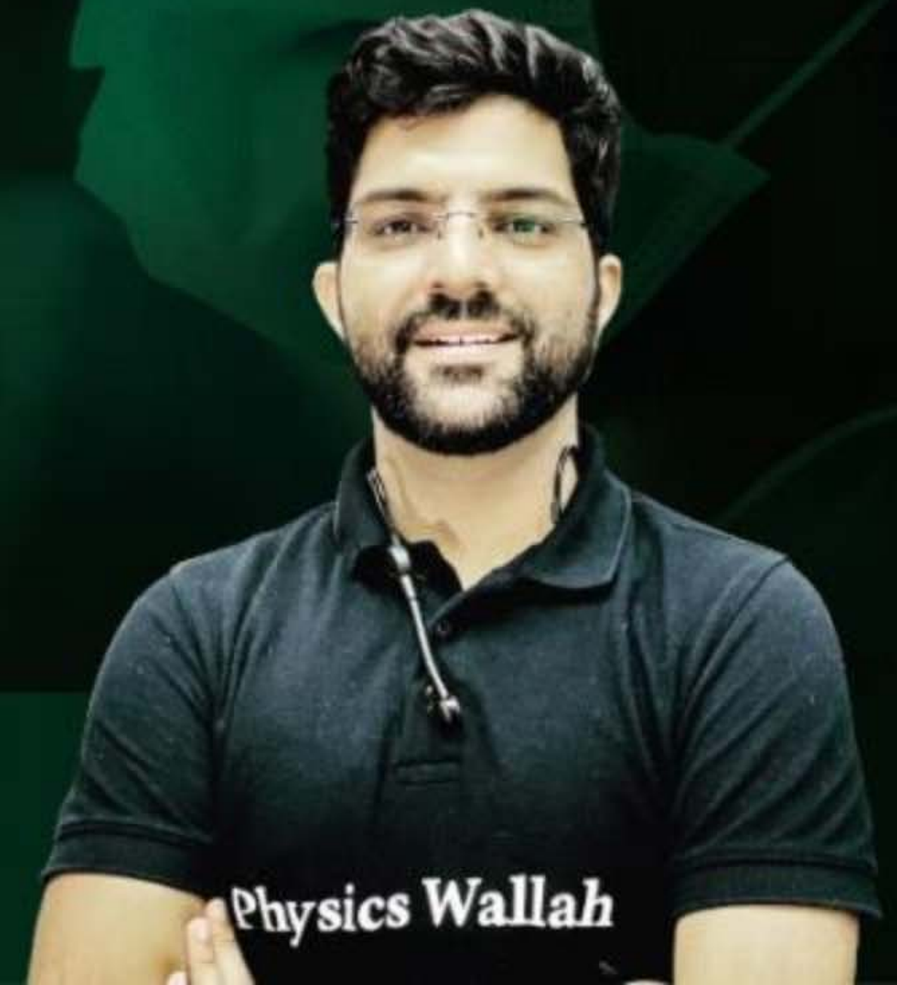
FOR NEET 2025

Lecture - 10 | Inorganic Chemistry

Classification of Elements
and
Periodicity in Properties

By - Mohit Dadheech (MD Sir)



Topics *to be covered*

1. Electronegativity (Part-02)

(2) Development of Periodic Table (History)

QUESTION

For electron gain enthalpies of the elements denoted as $\Delta_{eg}H$, the incorrect option is:

A $\Delta_{eg}H(Te) < \Delta_{eg}H(Po)$ ✓

B $\Delta_{eg}H(Se) < \Delta_{eg}H(S)$ ✗

C $\Delta_{eg}H(Cl) < \Delta_{eg}H(F)$ ✓

D $\Delta_{eg}H(I) < \Delta_{eg}H(At)$ ✓

−320 −180 Large

Cl > F > Br > I > At

−350 −200 −100

ΔH_{eg}

S > Se > Te > Po > O

−300 −200 −150 −100 −50

Low EA

JEE Mains

−150 → Small Value

ΔH_{eg}

High EA

Q Compare electron gain enthalpy in Halogens (with negative sign)

$F < Cl > Br > I$

$Cl > F > Br > I$

$-350 \quad -320 \quad -200 \quad -180$

EA

QUESTION

(Inertgas, N, Be, Mg)

Inert gases have positive electron gain enthalpy. Its correct order is

A. He < Xe < Kr < Ne

B. He < Ne < Kr < Xe

C. Xe < Kr < Ne < He

D. He < Kr < Xe < Ne

According to NCERT Data

* He +48
* Ne +116
Ar +96
Kr +96
Xe +77
Rn +68

Electronegativity :

* Unitless quantity

(Covalent Bond)

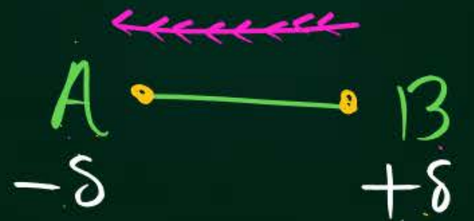
"The tendency of an atom to attract the shared pair of electrons towards it self

- It does not depend on electronic configuration

If $\Delta EN > 1.7$] Ionic Bond.

If $\Delta EN \simeq 0.4$ to 1.7 Polar Covalent Bond

If $\Delta EN < 0.4$ Non polar covalent



If $EN_A > EN_B$

$\Delta EN \uparrow$

→ Bond polarity ↑se

→ % Ionic character ↑se.

Factors affecting EN :

- Size $\quad Size \propto \frac{1}{EN}$
- Z Effective $\quad Z_{eff} \propto EN$
- Oxidation state $\quad M^- \; M^0 \; M^+ \; M^{2+}$ → (O.S ↑ Z_{eff} ↑ EN ↑)
- % s character in Hybrid orbitals :-

	sp	sp^2	sp^3
% s	50	33	25
% p	50	66	75

% s ↑ EN ↑

$sp > sp^2 > sp^3$

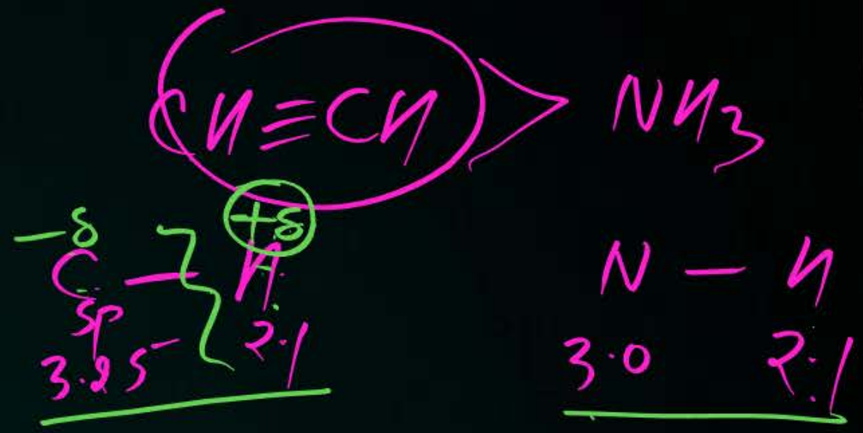
{Same Element can show diff EN values in diff O.S & Hybrid state.

$\overset{-3}{N}H_3 < \overset{+4}{N}O_2$ (EN of N)

Ex

$\overset{+3}{P}Cl_3 < \overset{+5}{P}Cl_5$ (EN)

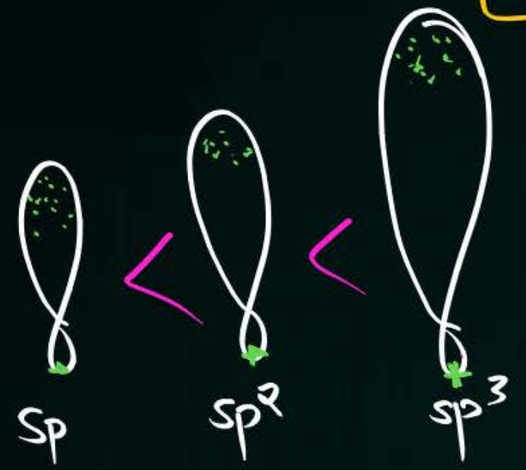
Ex	C_{sp}	C_{sp^2}	C_{sp^3}
	3.25	2.75	2.50


H≡CH
NH3
−δ
+δ
C
H
sp
3.25
2.1
N — H
3.0
2.1

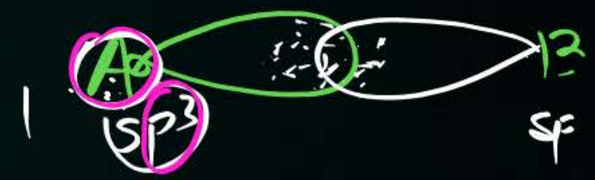
Size of Hybrid orbital

Shape → same !

Size



% p ↑se → Length of Hybrid orbital ↑se



Application of EN :

(1) Non metallic character

EN ↑ NMC ↑

(Ex) F Cl Br I

Size ↑, EN ↓, NMC ↓, Reactivity ↓

Reactivity of N.M ∝ EN

(2) Inter nuclear distance $d_{A-B} = r_A + r_B - 0.09 (X_A - X_B)$

or ΔEN

(3) % Ionic Character = $16 (\Delta EN) + 3.5 (\Delta EN)^2$

(4) Acidic/Basic/Amphoteric nature of oxides and hydroxides.

Q If $d_{A-A} = 1.00$, $d_{B-B} = 1.54$
& EN of A & B is 4.0 & 3.0 respectively. $\Big\}$ $\Delta EN = 4-3 = 1$
then find d_{A-B}.

$$r_A = \frac{d_{A-A}}{2} = \frac{1.00}{2} = 0.50$$

$$r_B = \frac{d_{B-B}}{2} = \frac{1.54}{2} = 0.77$$

$$d_{A-B} = r_A + r_B - 0.09(\Delta EN)$$

$$= 0.50 + 0.77 - 0.09(1)$$

Ans =

Find % Ionic Character in HF

given - EN of F = 4.0

EN of H = 2.1

ΔEN 4.0 − 2.1

1.9

$$\%IC = 16\,\Delta EN + 3.5\,(\Delta EN)^2$$

$$= 16 \times 1.9 + 3.5\,(1.9)^2$$

$\%IC =$

Different scales of EN :

- **Pauling scale** - Based on bond energy

H 2.1						
Li 1.0	Be 1.5	B 2.0	C 2.5	N 3.0	O 3.5	F 4.0
Na 0.9	Mg 1.2	Al 1.5	Si 1.8	P 2.1	S 2.5	Cl 3.0
K 0.8						Br 2.8
Rb 0.8						I 2.5
Cs 0.7						
Fr 0.7						

- **Mulikan scale** - Based on IP and EA

$$EN_{M.S} = \frac{IP+EA}{2}$$

$$EN_{P.S} = \frac{EN_{M.S}}{2.8}$$

$$EN_{M.S} = 2.8 \times EN_{2.8}$$

QUESTION

Electronegativity of the following elements increases in the order.

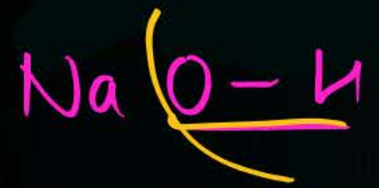
A O, N, S, P

B P, S, N, O

C P, N, S, O

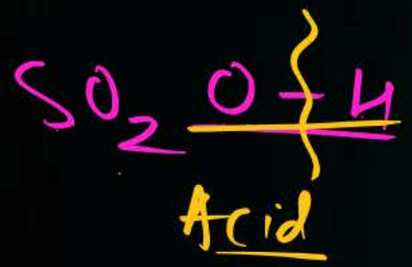
D S, P, N, O

Acidic/Basic Nature of O^{2-}/OH



NaOH
Base

Na_2O
Basic

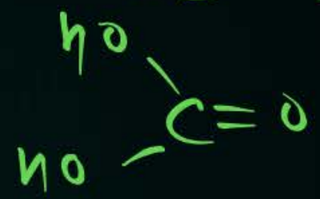


$Ca(OH)_2$
Base

CaO
Basic.

$SO_2(OH)_2$
Acidic
or
H_2SO_4

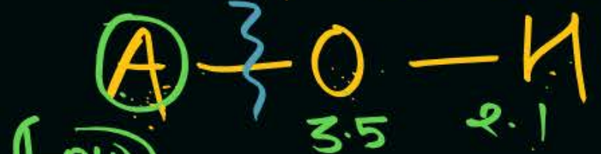
SO_3
Acidic.



$H_2CO_3 \rightarrow CO_2$
Acidic.

$CO(OH)_2$
Acidic

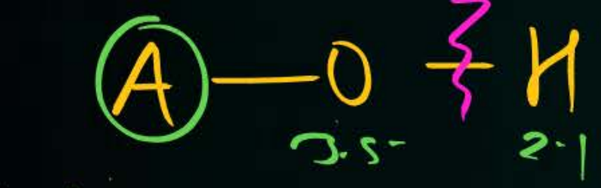
ΔEN_1 ΔEN_2



Low EN

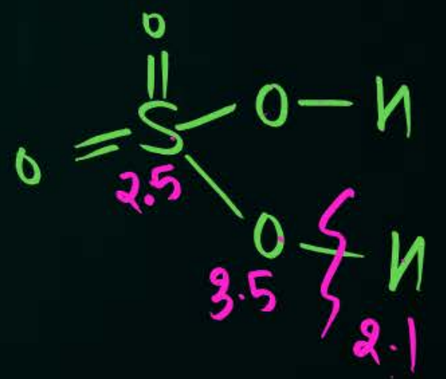
$$A{-}O{-}H \longrightarrow A^{+} + OH^{-}$$ Base

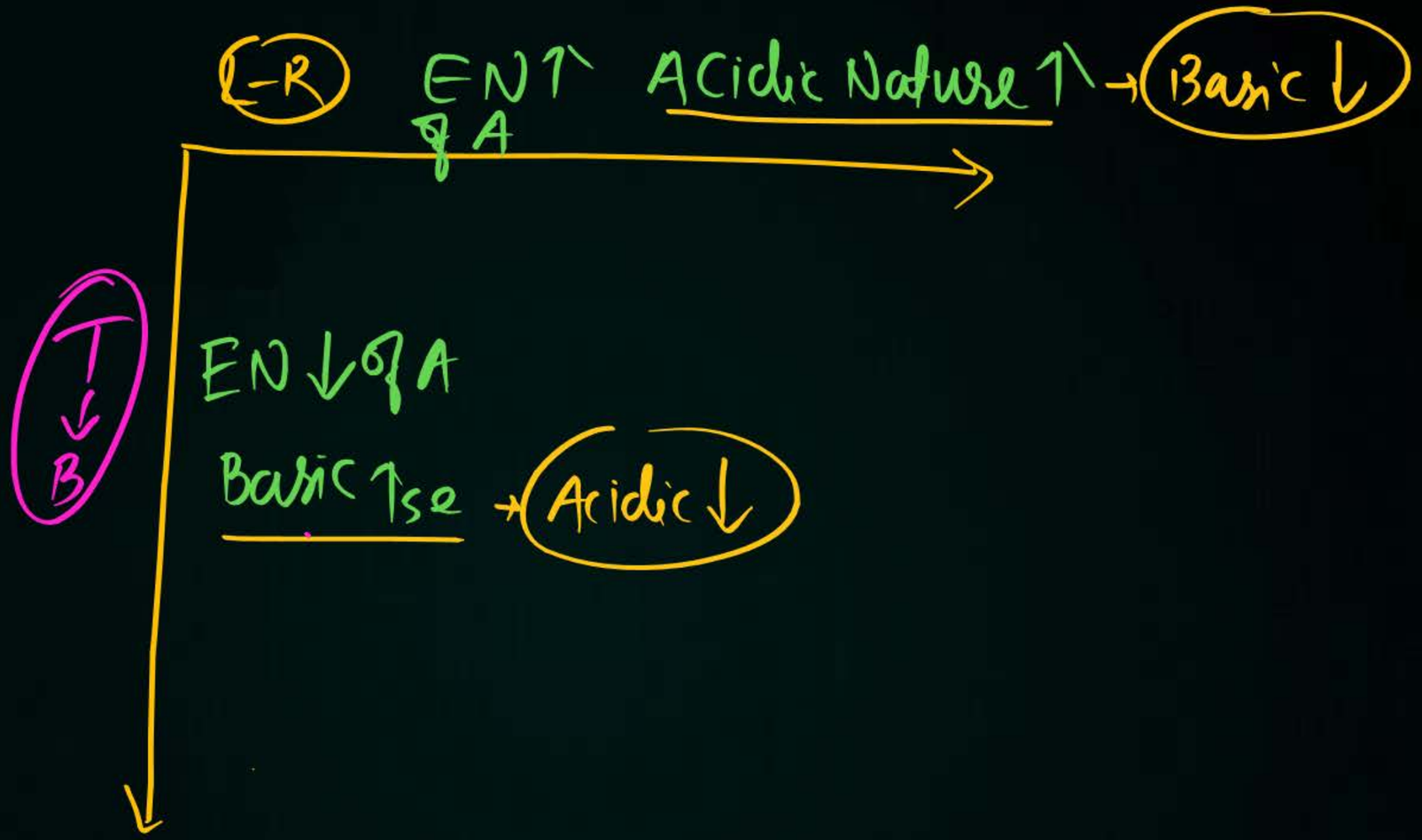
Na	O	H
0.9	3.5	2.1



$$A{-}O{-}H \longrightarrow AO^{-} + H^{+}$$ Acid

High EN




(-R)
EN↑
of A
ACidic Nature ↑
Basic ↓
T ↓
B
EN ↓ of A
Basic ↑ se
Acidic ↓

QUESTION

Compare Acidic/Basic nature in following

$NaOH > Mg(OH)_2 > Al(OH)_3 > Si(OH)_4$ (Basic)

$Li_2O < Na_2O < K_2O$ (Basic)

$Li_2O < BeO < B_2O_3$ (acidic)

$P_4O_{10} < SO_3 < Cl_2O_7$ (acidic)

$MnO > Mn_2O_3 > Mn_2O_7$ (Basic)

+2 +3 +7

O.S ↑ EN ↑ A ↑ B ↓

+3 +5

$HNO_2 < HNO_3$ (acidic)

$HClO_2 < HClO_3 < HClO_4$ (acidic)

+3 +5 +7

Some Imp. Points

(1) gen Metal oxides are Basic in nature
↳ Low EN → Basic

(2) gen Non Metal oxides are acidic in Nature
↳ High EN → Acidic

(3) Amphoteric O^{2-}/OH^-

Can act as acidic as well Basic

Zn Al Sb As Pb Be Sn Ga Cr^{3+}

Zn Janabe Al Sabse Sb Achha As Pb Punjabi Be Sn Song Ga Gayg Cr Kero

(4) Some Neutral oxides

H_2O, NO, N_2O, CO

QUESTION

Which of the following oxides is amphoteric in nature ?

A CaO

B CO_2

C SiO_2

D SnO_2

Genesis of periodic classification (Development of periodic table) :

(i) Dobereiner Triads

- Li, Na, K is dobernier triads because atomic wt. of Na is equal to average atomic wt. of Li & K.

Jugad : Same group
ΔZ same

$8[{}_{3}Li \quad {}_{11}Na \quad {}_{19}K$ ✓✓

$8[{}_{4}Be \quad {}_{12}Mg \quad {}_{20}Ca$ ✓✓

$8[{}_{9}F \quad {}_{17}Cl \quad {}_{35}Br$ XX

$18[{}_{17}Cl \quad {}_{35}Br \quad {}_{53}I$ ✓✓

$18[{}_{18} \quad {}_{19} \quad {}_{35}Br$ XX

Fe, Co, Ni — same period

(ii) De chancourtois

- 3D model & DNA Helix like structure.

(iii) **Newlands octave rule**

sa	re	ga	ma	pa	dha	ni
Li	Be	B	C	N	O	F
sa						
Na						

Jugad : Same group

$\Delta Z = 8$

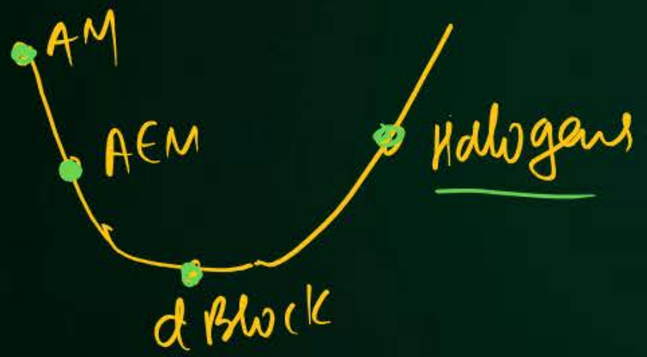
Disadvantage :

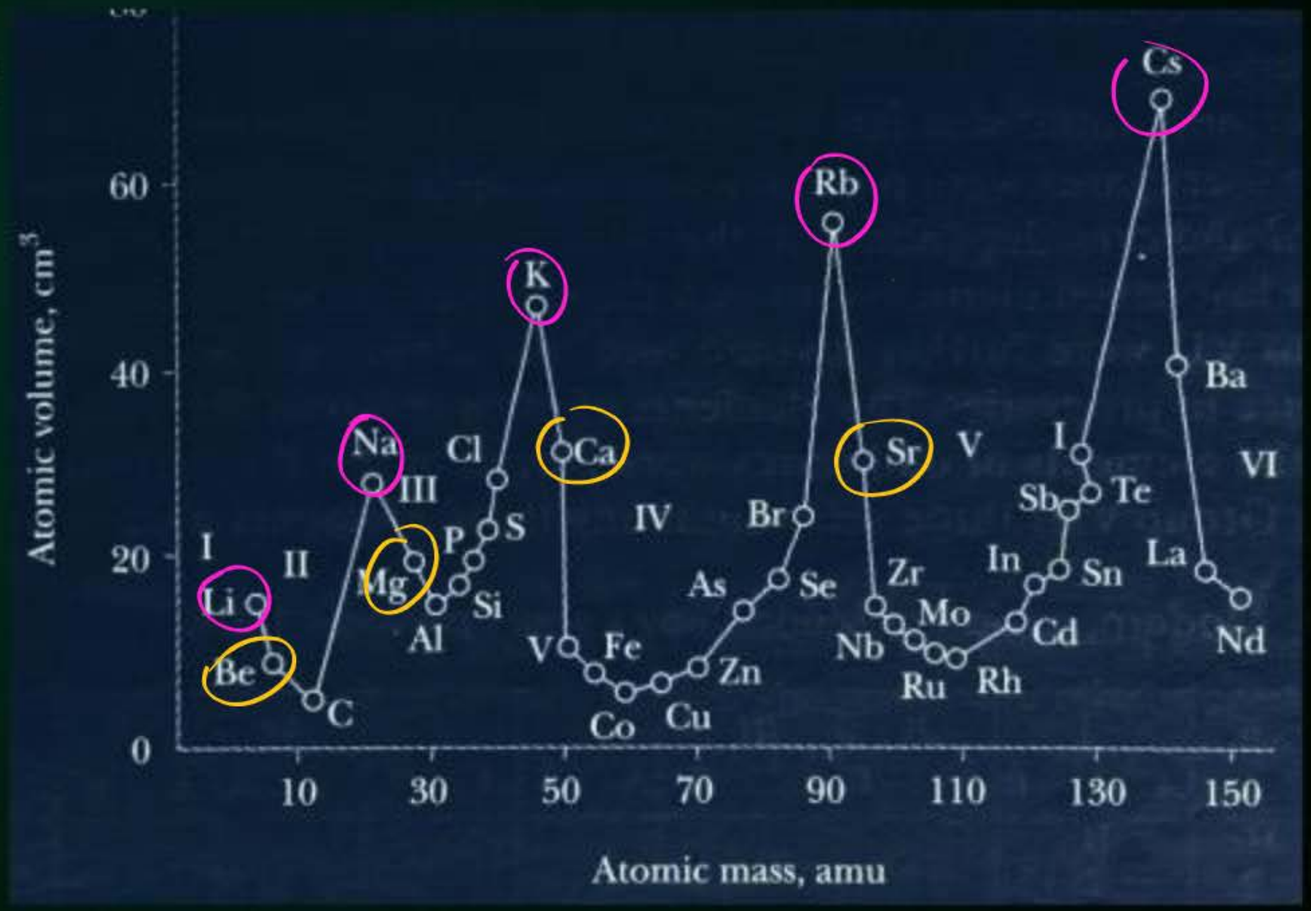
- Newlands's Law of Octaves seemed to be true only for elements up to calcium.
- after discovery of Inert gases this is Completely failed

(iv) Lothar Meyer curve

- Plotted Graph atomic mass *vs* atomic volume.

Peak position-Alkali metals ✓
Descending-alkaline earth metals
Ascending – Halogens
Bottom part – d-block elements





(v) Mendeleev's periodic table

"The properties of the elements are a periodic function of their atomic weights".

- **Advantages :**

(a) Discovery of new elements

Al	B	Si	Mn
|	|	|	|
Ga	Sc	Ge	Tc
[Eka aluminum]	[Eka Boron]	[Eka Silicon]	[Eka manganese]

ganga se Jamuna Tak

(b) Correction in Atomic weight of some element

Au	In	Pt	Be	U
Gold	In	Platinum	becomes	Utimate

- **Disadvantage :**
  Some element do not follows trend of increasing atomic weight.

Ar	–	K
Amir.		Khan
Te	–	I
Teri		Ichha.
Th	–	Pa
Thanda		Pani
Co	–	Ni
Kyo		Nahi

Anomalous Pair

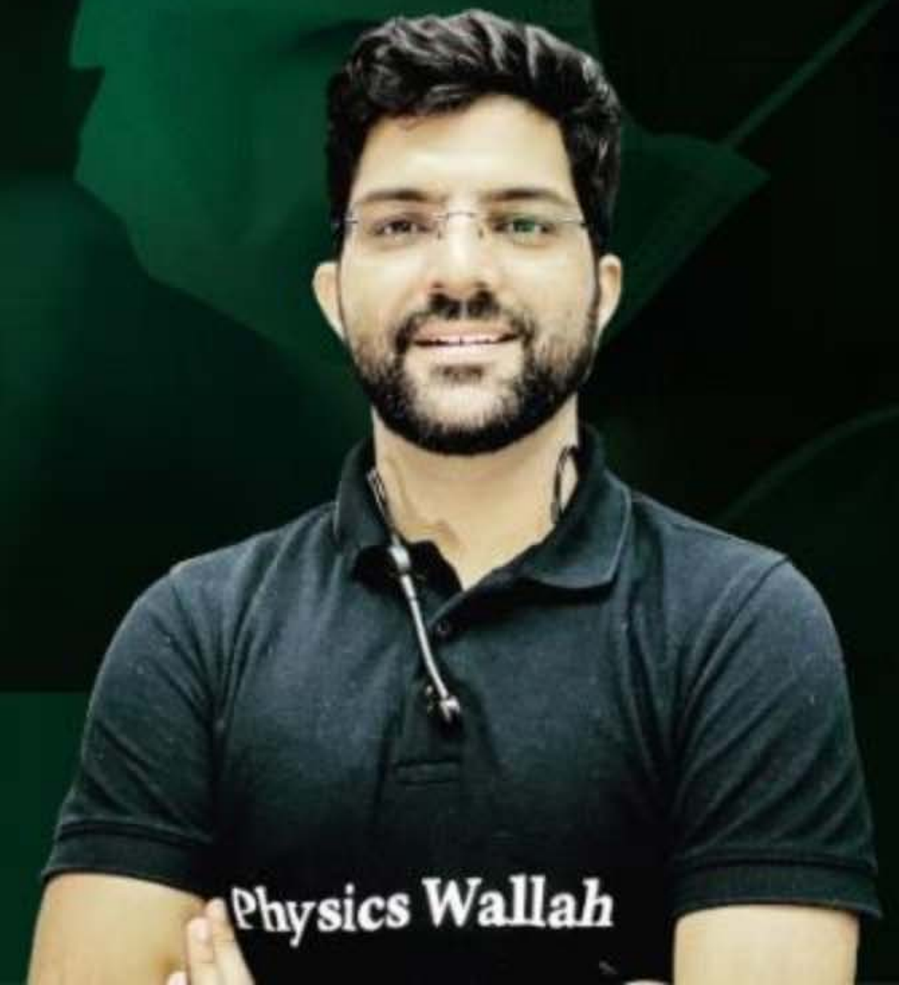
THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture - 11 | Inorganic Chemistry

Classification of Elements and Periodicity in Properties



By - Mohit Dadheech (MD Sir)

Topics *to be covered*

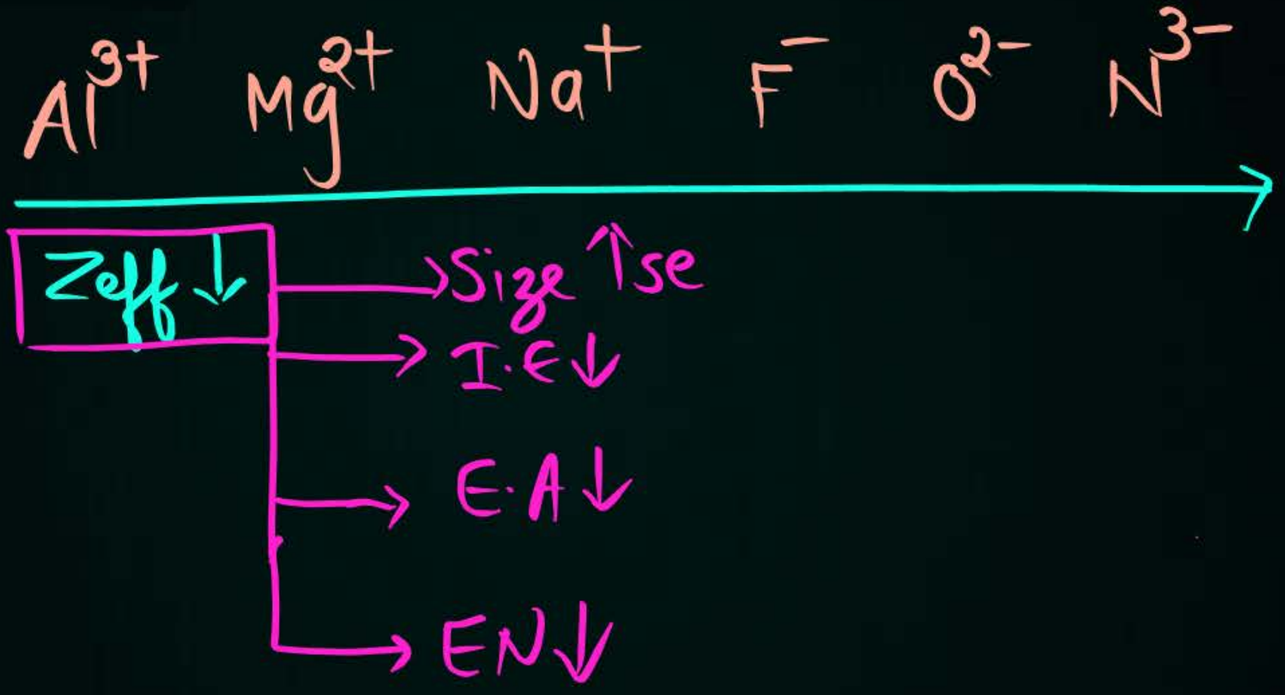
1. Some important points
2. NCERT Lines
3. Questions Practice

Some important points

1. Properties in isoelectronic series & ions of same element.
2. Ionization energy : f block
3. Diagonal relationship

Trend of Various properties in Isoelectronic Series

$Z_{eff} \propto \frac{+ve}{-ve}$



Trend of Various properties in ions of same element

Ionisation Energy (f-Block) (Lanthanoids)

Some imp points :- (NCERT 12th d & f Block)

* IE_1 (600) & IE_2 (1200) of lanthanoids are similar to Calcium

* IE_3 of La Gd Lu is abnormally low as compare to other elements

Reason:- All these three element will achive stable configuration after removal of 3rd e^-

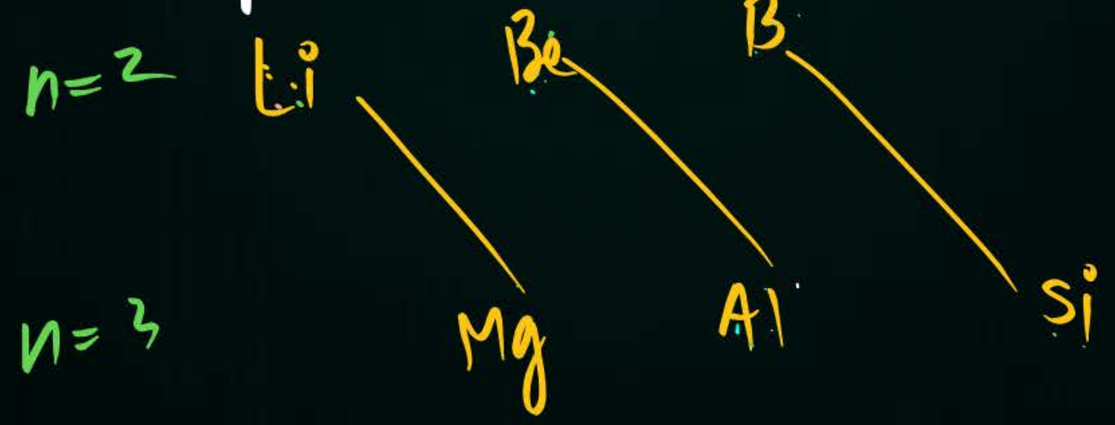
La $[Xe]\ 5d^1 6s^2$ will achive inert gas

Gd $[Xe]\ 4f^7 5d^1 6s^2$ will achive Half filled

Lu $[Xe]\ 4f^{14} 5d^1 6s^2$ will achive full filled

Diagonal Relationship :-

A phenomenon in which certain pairs of elements diagonally adjacent to each other in 2nd & 3rd Periods having similar properties



Reason of diagonal Relationship

(Ionic Potential)

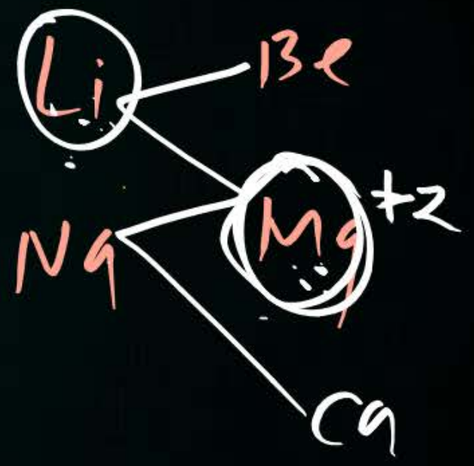
(i) Similar polarising power

Polarising Power $\propto$ $\frac{\text{Charge}}{\text{Radius}}$

ϕ

$Li^+ \simeq Mg^{2+}$

$\phi \propto \frac{q}{r}$

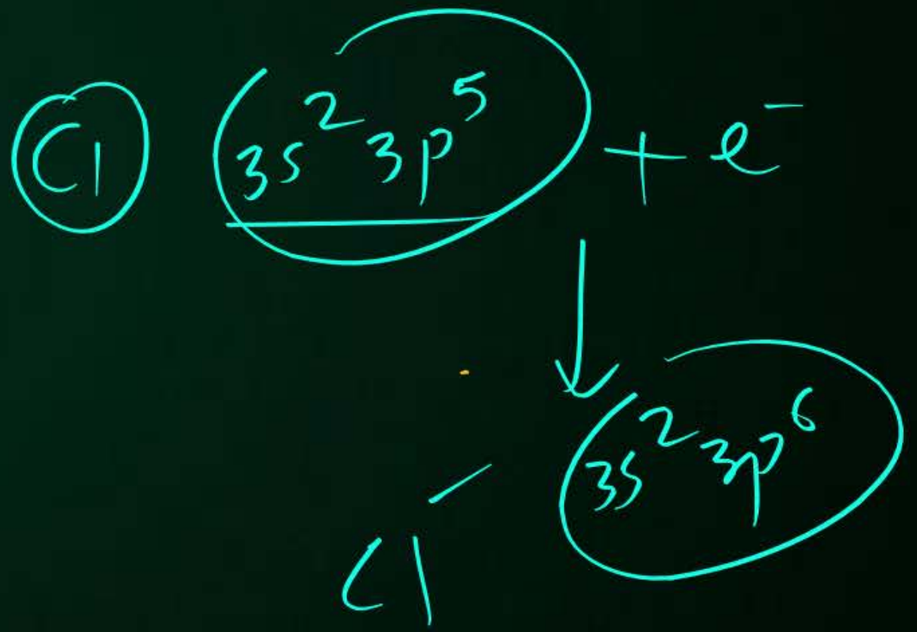


NCERT KI CHOTI CHOTI MAGAR MOTI BAATEIN

EA

EA

Depending on the element, the process of adding an electron to the atom can be either endothermic or exothermic. For many elements energy is released when an electron is added to the atom and the electron gain enthalpy is negative. For example, group 17 elements (the halogens) have very high negative electron gain enthalpies because they can attain stable noble gas electronic configurations by picking up an electron.



On the other hand, noble gases have large positive electron gain enthalpies because the electron has to enter the next higher principal quantum level leading to a very unstable electronic configuration. It may be noted that electron gain enthalpies have large negative values toward the upper right of the periodic table preceding the noble gases.

before

Halogen

F Ne

(n)

(Ne) $1s^2 2s^2 2p^6 + e^-$

$1s^2 2s^2 2p^6 | 3s |$

The variation in electron gain enthalpies of elements is less systematic than for ionization enthalpies. As a general rule, electron gain enthalpy becomes more negative with increase in the atomic number across a period. The effective nuclear charge increases from left to right across a period and consequently it will be easier to add an electron to a smaller atom since the added electron on an average would be closer to the positively charged nucleus. We should also expect electron gain enthalpy to become less negative as we go down a group because the size of the atom increases and the added electron would be farther from the nucleus.

Electron gain enthalpy of O or F is less negative than that of the succeeding element. This is because when an electron is added to O or F, the added electron goes to the smaller n = 2 quantum level and suffers significant repulsion from the other electrons present in this level. For the n = 3 quantum level (S or Cl), the added electron occupies a larger region of space and the electron-electron repulsion is much less.

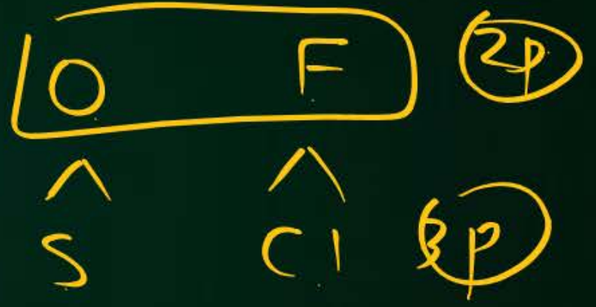


Table 3.7 Electron Gain Enthalpies* / (kJ mol^{-1}) of Some Main Group Elements

Group 1	$\Delta_{eg}H$	Group 16	$\Delta_{eg}H$	Group 17	$\Delta_{eg}H$	Group 0	$\Delta_{eg}H$
H	– 73					**He**	+ 48
Li	– 60	**O**	– 141	**F**	– 328	**Ne**	+ 116
Na	– 53	**S**	– 200	**Cl**	– 349	**Ar**	+ 96
K	– 48	**Se**	– 195	**Br**	– 325	**Kr**	+ 96
Rb	– 47	**Te**	– 190	**I**	– 295	**Xe**	+ 77
Cs	– 46	**Po**	– 174	**At**	– 270	**Rn**	+ 68

Valence shell :- gen. outer most shell

$1s^2 2s^2 2p^6 \underbrace{3s^2}$

Valence shell = 3
Valence e^- = 2 (0s +2)

In Many Cases

0.s is similar to Valence e^-

The valence is the most characteristic property of the elements and can be understood in terms of their electronic configurations. The valence of representative elements is usually (though not necessarily) equal to the number of electrons in the outermost orbitals and/or equal to eight minus the number of outermost electrons as shown below.

→ S & P Block Elements (According to NCERT)

ns^1 ns^2 ns^2np^1 ns^2np^2 ns^2np^3 ns^2np^4 ns^2np^5 ns^2np^6

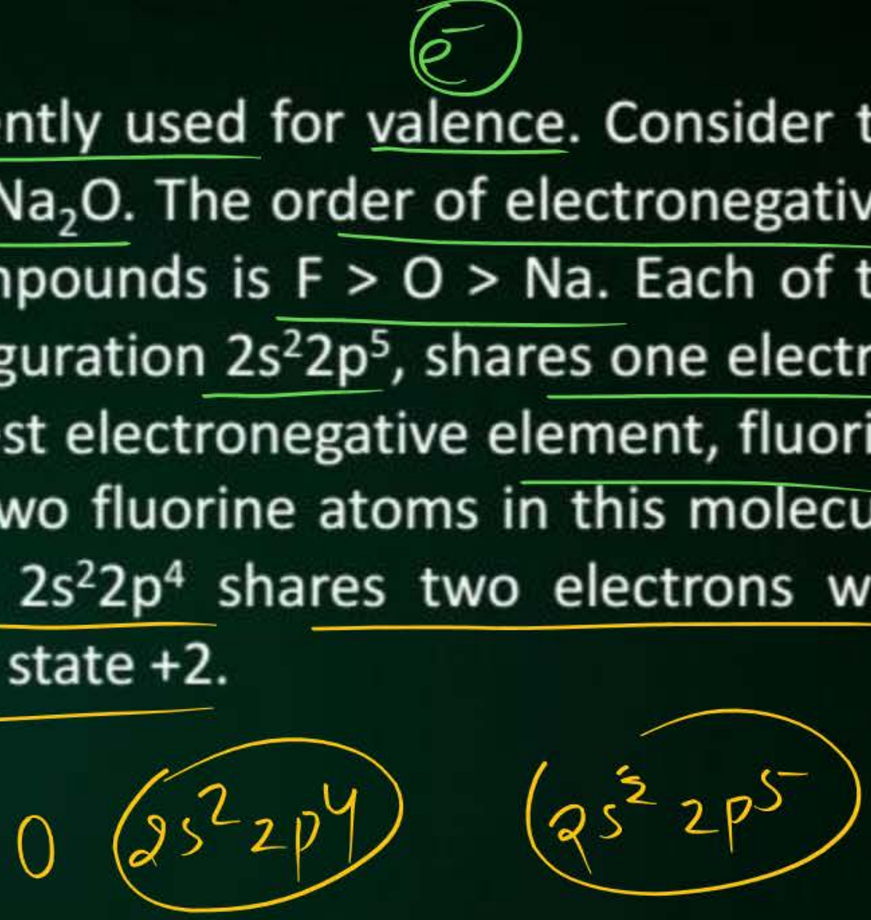
Group	1	2	13	14	15	16	17	18
Number of valence electron	1	2	3	4	5	6	7	8
Valence e^- / O.S	1	2	3	4	3,5	2,6	1,7	0,8

(5)

or

8-5=3

Nowadays the term oxidation state is frequently used for valence. Consider the two oxygen containing compounds: OF_2 and Na_2O. The order of electronegativity of the three elements involved in these compounds is F > O > Na. Each of the atoms of fluorine, with outer electronic configuration $2s^2 2p^5$, shares one electron with oxygen in the OF_2 molecule. Being highest electronegative element, fluorine is given oxidation state –1. Since there are two fluorine atoms in this molecule, oxygen with outer electronic configuration $2s^2 2p^4$ shares two electrons with fluorine atoms and thereby exhibits oxidation state +2.



In Na_2O, oxygen being more electronegative accepts two electrons, one from each of the two sodium atoms and, thus, shows oxidation state –2. On the other hand sodium with electronic configuration 3s1 loses one electron to oxygen and is given oxidation state +1. Thus, the oxidation state of an element in a particular compound can be defined as the charge acquired by its atom on the basis of electronegative consideration from other atoms in the molecule.

Na_2O Na^{+1} O^{2-}

Low EN — — High EN

ClNa ✗ NaCl ✓

Table 3.9 Periodic Trends in Valence of Elements as shown by the Formulas of Their Compounds

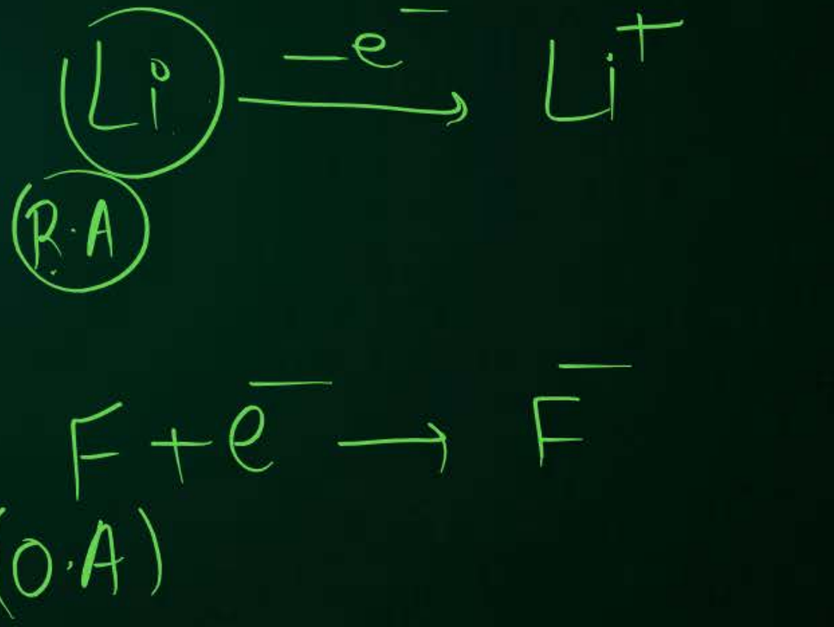
Group	1	2	13	14	15	16	17
Formula of hydride	LiH NaH KH	CaH_2	B_2H_6 AlH_3	CH_4 SiH_4 GeH_4 SnH_4	NH_3 PH_3 AsH_3	H_2O H_2S H_2Se H_2Te	HF HCl HBr HI
Formula of oxide	Li_2O Na_2O K_2O	MgO CaO SrO BaO	B_2O_3 Al_2O_3 Ga_2O_3 In_2O_3	CO_2 SiO_2 GeO_2 SnO_2 PbO_2	N_2O_3, N_2O_5 P_4O_6, P_4O_{10} As_2O_3, As_2O_5 Sb_2O_3, Sb_2O_5 Bi_2O_3 –	SO_3 SeO_3 TeO_3 –	– Cl_2O_7 – –

+3 +5

The atomic and ionic radii, as we know, generally decrease in a period from left to right. As a consequence, the ionization enthalpies generally increase (with some exceptions as outlined in section and electron gain enthalpies become more negative across a period. In other words, the ionization enthalpy of the extreme left element in a period is the least and the electron gain enthalpy of the element on the extreme right is the highest negative (note : noble gases having completely filled shells have rather positive electron gain enthalpy values).

This results into high chemical reactivity at the two extremes and the lowest in the centre. Thus, the maximum chemical reactivity at the extreme left (among alkali metals) is exhibited by the loss of an electron leading to the formation of a cation and at the extreme right (among halogens) shown by the gain of an electron forming an anion.

This property can be related with the reducing and oxidizing behaviour of the elements which you will learn later. However, here it can be directly related to the metallic and non-metallic character of elements. Thus, the metallic character of an element, which is highest at the extremely left decreases and the non-metallic character increases while moving from left to right across the period.

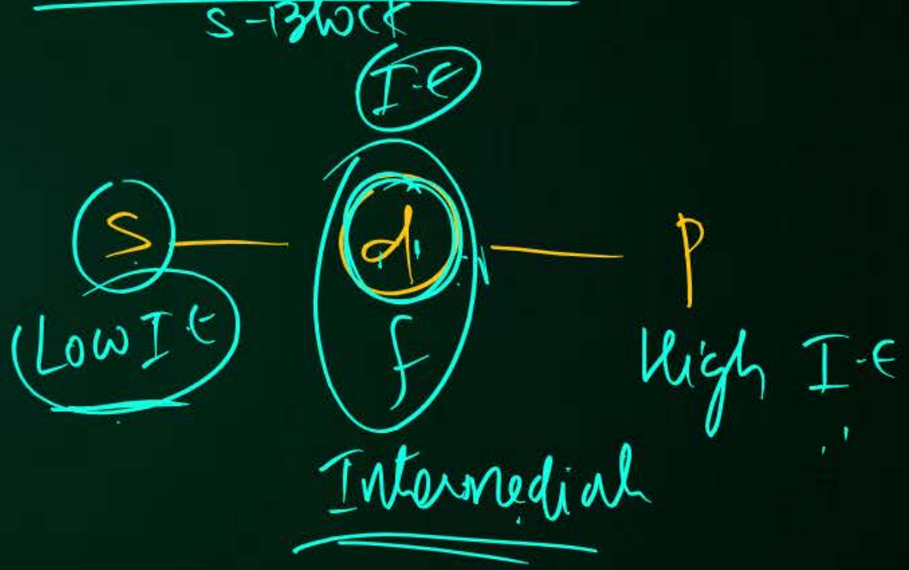


The normal oxide formed by the element on extreme left is the most basic (e.g., Na_2O), whereas that formed by the element on extreme right is the most acidic (e.g., Cl_2O_7). Oxides of elements in the centre are amphoteric (e.g., Al_2O_3, As_2O_3) or neutral (e.g., CO, NO, N_2O). Amphoteric oxides behave as acidic with bases and as basic with acids, whereas neutral oxides have no acidic or basic properties.

d-Block

≃ 5 nm

Among transition metals (3d series), the change in atomic radii is much smaller as compared to those of representative elements across the period. The change in atomic radii is still smaller among inner-transition (f-Block) metals (4f series). The ionization enthalpies are intermediate between those of s- and p-blocks. As a consequence, they are less electropositive than group 1 and 2 metals.



Thus, the metallic character increases down the group and non-metallic character decreases. This trend can be related with their reducing and oxidizing property which you will learn later. In the case of transition elements, however, a reverse trend is observed. This can be explained in terms of atomic size and ionization enthalpy.

QUESTION

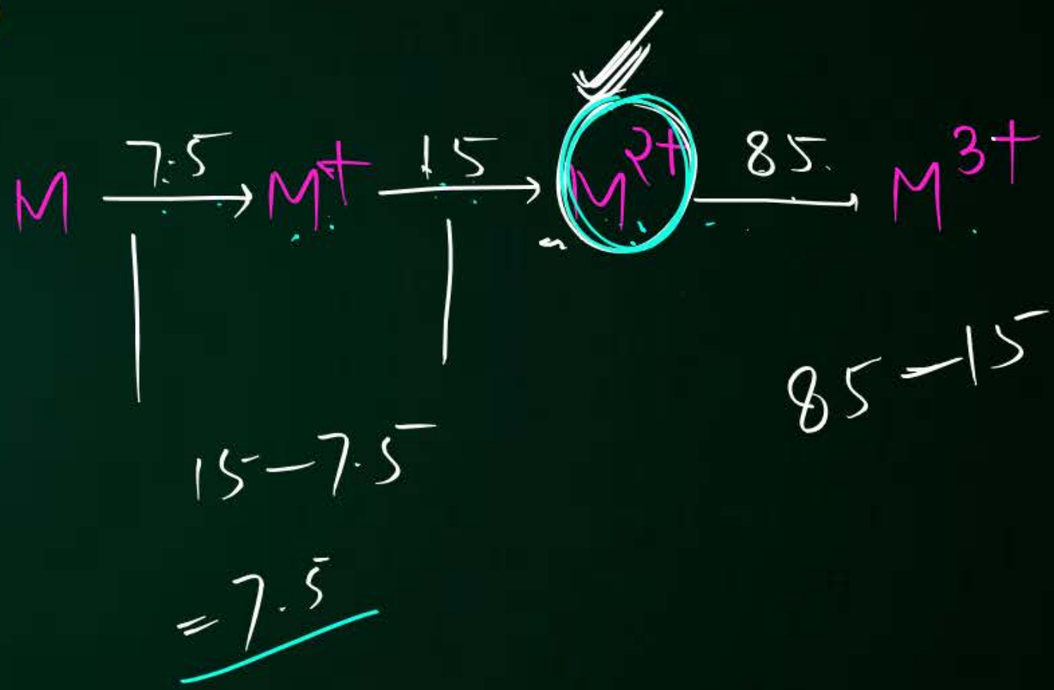
In which of the following change, observed energy represent first ionization energy of given element ?

1. $Na(s) \rightarrow Na^{+}(g)$
2. $1/2F_2(g) \rightarrow F^{+}(g)$
3. $Mg(g) \rightarrow Mg^{+2}(g)$
4. $Cl(g) \rightarrow Cl^{+}(g)$

QUESTION

Three successive I.P. value of an element is 7.5 eV, 15 eV and 85 eV. The most stable oxidation state of element is :

1. M^{+}
2. M^{+2}
3. M^{+3}
4. Cannot predicated



QUESTION

The second ionization energy is maximum for :

1. Boron $2s^2 2p^1$ $2s^2$ $s^1 < s^2$
2. Beryllium $2s^2$ $2s^1$
3. Magnesium $3s^2$ $3s^1$ X
4. Aluminium $3s^2 3p^1$ $3s^2$ X

QUESTION

Element which have maximum and minimum electron gain enthalpy in chalcogen family are respectively :

(oxygen)

1. O, Po
2. S, Po
3. S, O
4. O, S

S > Se > Te > Po > O

QUESTION

Xe has maximum EN in :

O.S ↑ EN ↑

1. XeF_2
2. XeF_4
3. $XeOF_4$
4. Equal EN in all compounds

QUESTION

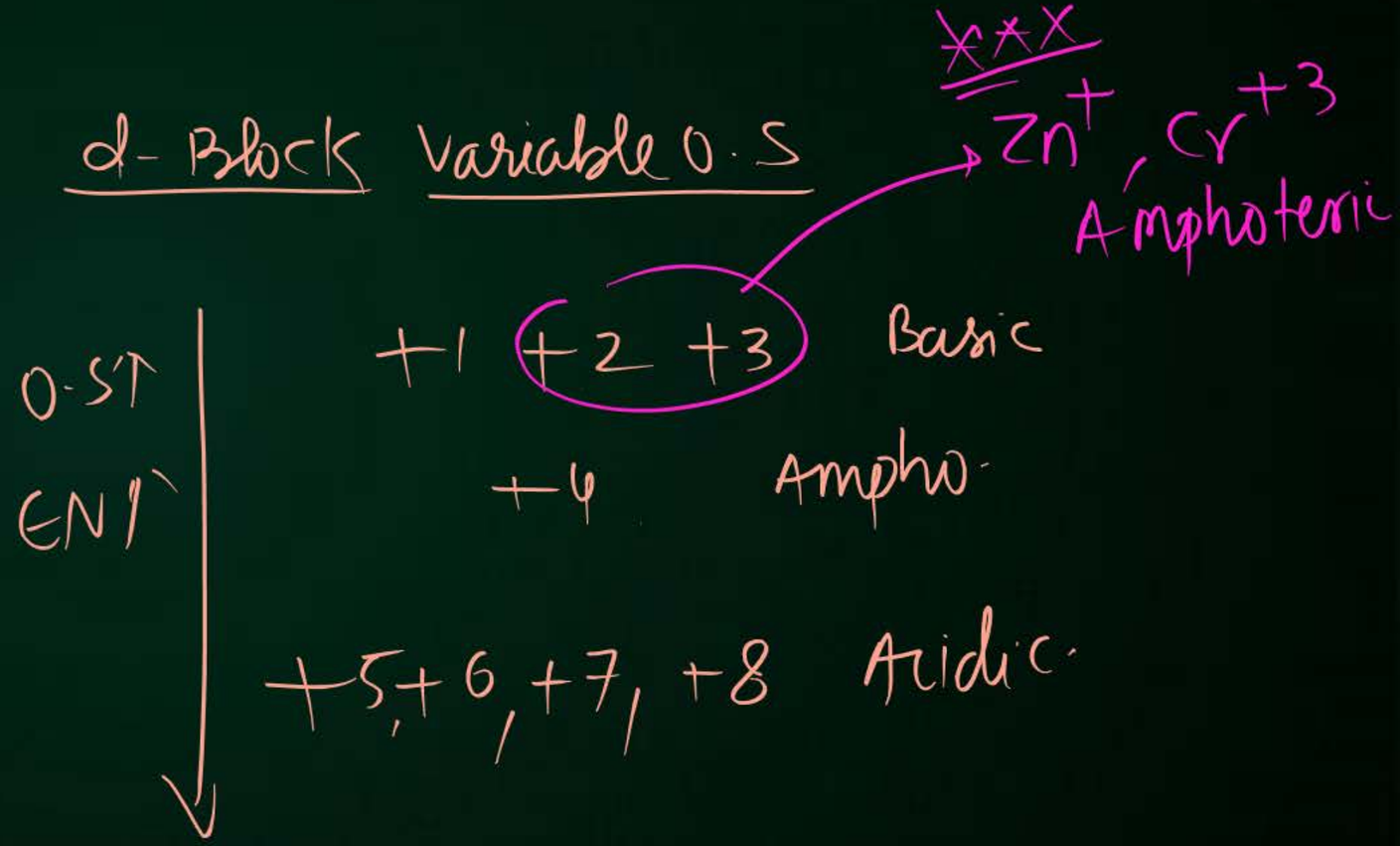
Following are neutral oxides except :

1. NO
2. N_2O
3. CO
4. NO_2 Acidic

QUESTION

Which of the following oxide is Acidic ?

1. N_2O_5
2. Mn_2O_7
3. CrO_3
4. All



QUESTION

Which compound strongly absorb CO_2 ?

Acidic

1. BeO
2. K_2O
3. H_3PO_4
4. P_4O_6

QUESTION

Which of the following salt has maximum pH in aqueous solution ?

H_2O

$H^+ \{ OH^-$

1. $AlCl_3$ $Al(OH)_3$
2. $ZnCl_2$ $Zn(OH)_2$
3. $BaCl_2$ $Ba(OH)_2$ ✓
4. $MgCl_2$ $Mg(OH)_2$

QUESTION

Correct basic strength order is

1. $Er(OH)_3 > Nd(OH)_3 > Pm(OH)_3 > Sm(OH)_3$
2. $Nd(OH)_3 > Sm(OH)_3 > Pm(OH)_3 > Er(OH)_3$
3. $Nd(OH)_3 > Pm(OH)_3 > Sm(OH)_3 > Er(OH)_3$
4. $Er(OH)_3 > Pm(OH)_3 > Sm(OH)_3 > Nd(OH)_3$

EN

f - Block

Lanthanoids

gen. L → R Size ↓

$Ce^{+3} \longrightarrow Lu^{3+}$

EN ↑

Acidic ↑

Basic ↓

QUESTION

Assertion : Elements of a period exhibits similar chemical properties.
Reason : Elements of a group possess same electronic configuration of their outermost shell.

1. Both assertion and reason are correct and reason is correct for the assertion
2. Both assertion and reason are correct and reason is not correct for the assertion
3. Assertion is correct but reason is correct
4. Assertion is incorrect but reason is correct

QUESTION

NOTES

Mg Valq Example

Assertion : Alkaline earth metals show +2 oxidation state.

Reason : IP_2 and IP_3 is more than 16 eV for IIA metals.

group 2

1. Both assertion and reason are correct and reason is correct for the assertion
2. Both assertion and reason are correct and reason is not correct for the assertion
3. Assertion is correct but reason is correct
4. Assertion is incorrect but reason is correct

IE_1 IE_2 } IE_3 IE_4

QUESTION

Assertion : Ionization energy of Ne is greater as compare of Ne^+. ✗
Reason : Ne has p^6 (full filled electronic configuration) but Ne^+ has p^5 configuration of outermost subshell. ✓ But not Correct Explanation.

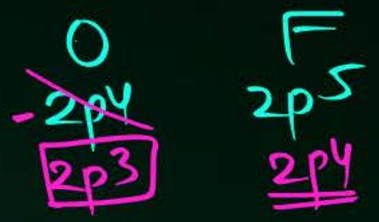
1. Both assertion and reason are correct and reason is correct for the assertion
2. Both assertion and reason are correct and reason is not correct for the assertion
3. Assertion is correct but reason is correct
4. Assertion is incorrect but reason is correct ✓

QUESTION

Assertion : I.P. of first element in a period is minimum.
Reason : Effective nuclear charge of first element in a period is minimum.

1. Both assertion and reason are correct and reason is correct for the assertion
2. Both assertion and reason are correct and reason is not correct for the assertion
3. Assertion is correct but reason is correct
4. Assertion is incorrect but reason is correct

QUESTION



Assertion : Second IP of oxygen is greater than that of fluorine.
Reason : Oxygen acquires stable half filled electronic configuration after loosing one electron.

1. Both assertion and reason are correct and reason is correct for the assertion
2. Both assertion and reason are correct and reason is not correct for the assertion
3. Assertion is correct but reason is correct
4. Assertion is incorrect but reason is correct

QUESTION

Which of the following is the most basic oxide ?

[AIPMT - 2006]

1. SeO_2
2. Al_2O_3
3. Sb_2O_3
4. Bi_2O_3

QUESTION

Which of the following oxides is not expected to react with sodium hydroxide ?

[AIPMT - 2009]

1. BeO
2. B_2O_3
3. CaO
4. SiO_2

NaOH Base.

Basic

QUESTION

Reason of lanthanoid contraction is :

[AIPMT - 2014]

1. Negligible screening effect of '4f' e^-

2. Increasing nuclear charge

3. Decreasing nuclear charge

4. Decreasing screening effect

QUESTION

Which of the following statement is incorrect for an atom having electronic configuration 2, 8, 7

[AIPMT 1995]

1. It forms diatomic molecules Cl_2
2. It is a non metal element
3. Its valency is 1
4. It forms basic oxide

Cl

$1s^2$ $2s^2$ $2p^6$ $3s^2$ $3p^5$

2 8 7

QUESTION

Electronegativity is the measurement of capacity of an atom by which :

[AIPMT 1996]

1. Electrons get replled
2. Electrons get attracted
3. Gain of electron
4. Lose of proton

H.W

QUESTION

A transition element X has the configuration [Ar] $3d^4$ in its +3 oxidation state. Its atomic number is

[AIPMT 1996]

18 + 4 + 3

$Z = 25$

1. 25
2. 26
3. 22
4. 19

QUESTION

Which one of the following arrangements represents the correct order of electron gain enthalpy (with negative sign) of the given atomic species :-

[AIPMT 2005]

1. F < Cl < O < S
2. S < O < Cl < F
3. O < S < F < Cl
4. Cl < F < S < O

H.W

O < S < F < Cl

NOTES

QUESTION

The correct order regarding the electronegativity of hybrid orbitals of carbon is ?

[AIPMT 2006]

1. $sp < sp^2 < sp^3$

2. $sp > sp^2 < sp$

3. $sp > sp^2 > sp^3$

4. $sp < sp^2 > sp^3$

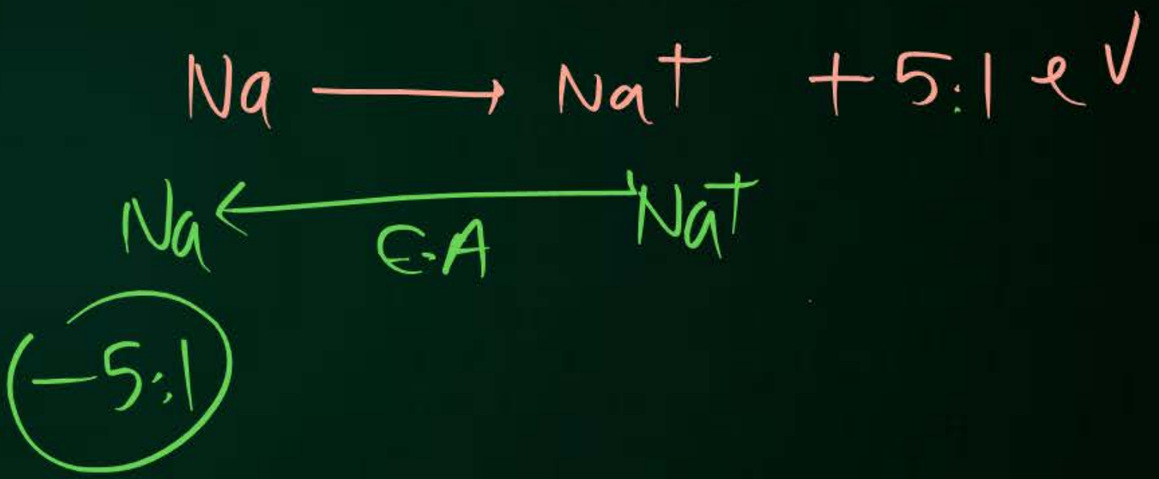
H.W

QUESTION

What is the value of electron gain enthalpy of Na^+ if IE_1 of Na = 5.1 eV :-

[AIPMT Mains 2011]

1. +0.2 eV
2. −5.1 eV
3. −10.2 eV
4. +2.55 eV

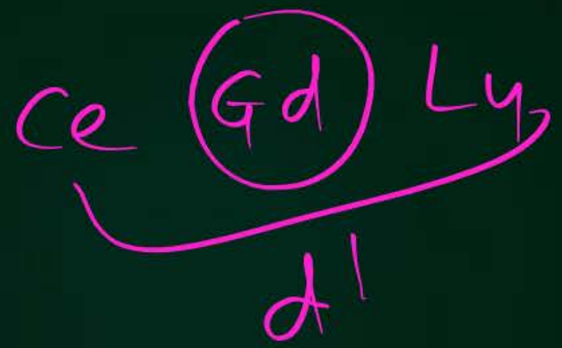


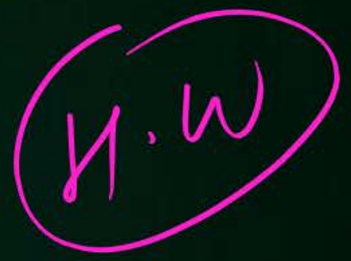
QUESTION

Gadolinium belongs to 4f series. It's atomic number is 64. Which of the following is the correct electronic configuration of gadolinium ?

[Re AIPMT 2015]

1. [Xe] $4f^7\ 5d^1 6s^2$
2. [Xe] $4f^6 5d^2 6s^2$
3. [Xe] $4f^8 6d^2$
4. [Xe] $4f^9 5s^1$





QUESTION

Which of the following oxides is most acidic in nature?

[NEET-2018]

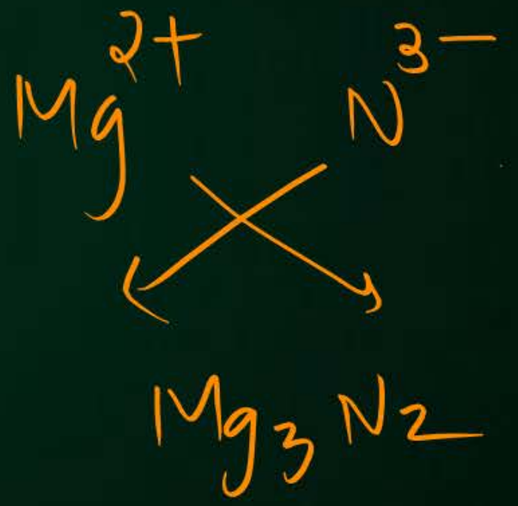
1. MgO
2. BeO
3. BaO
4. CaO

QUESTION

Magnesium reacts with an element (X) to form an ionic compound. If the ground state electronic configuration of (X) is $1s^2\ 2s^2\ 2p^3$, the simplest formula for this compound is :

[NEET-2018]

1. Mg_2X_3
2. MgX_2
3. Mg_2X
4. Mg_3X_2



QUESTION

Consider the isoelectronic species, Na^+, Mg^{2+}, F^- and O^{2-}. The correct order of increasing length of their radii is _____.

1. $F^- < O^{2-} < Mg^{2+} < Na^+$

H.W

2. $Mg^{2+} < Na^+ < F^- < O^{2-}$

3. $O^{2-} < F^- < Na^+ < Mg^2$

4. $O^{2-} < F^- < Mg^{2+} < Na^+$

QUESTION

Which of the following is not an actinoid ?

1. Curium (Z = 96)
2. Californium (Z = 98)
3. Uranium (Z = 92)
4. Terbium (Z = 65)

HW

QUESTION

The order of screening effect of electrons of s, p, d and f orbitals of a given shell of an atom on its outer shell electrons is :

1. $s > p > d > f$
2. $f > d > p > s$
3. $f < d < s < p$
4. $f > p > s > d$

H.W

QUESTION

The first ionization enthalpies of Na, Mg, Al and Si are in the order :

1. Na < Mg < Si < Al

2. Na > Mg > Al > Si

3. Na < Al < Mg < Si

4. Na > Al > Mg > Si

H.W

QUESTION

The electronic configuration of gadolinium (Atomic number 64) is

H.W

1. $[Xe]\ 4f^3\ 5d^5\ 6s^2$
2. $[Xe]\ 4f^7\ 5d^2\ 6s^1$
3. $[Xe]\ 4f^7\ 5d^1\ 6s^2$
4. $[Xe]\ 4f^8\ 5d^6\ 6s^2$

QUESTION

The statement that is not correct for periodic classification of elements is :

1. The properties of elements are periodic function of their atomic numbers.
2. Non metallic elements are less in number than metallic elements.
3. For transition elements, the 3d-orbitals are filled with electrons after 3p-orbitals and before 4s-orbitals.
4. The first ionisation enthalpies of elements generally increase with increase in atomic number as we go along a period.

3s → 3p → | 4s → 3d → 4p |

n = 3 | n = 4

QUESTION

Among halogens, the correct order of amount of energy released in electron gain (electron gain enthalpy) is :

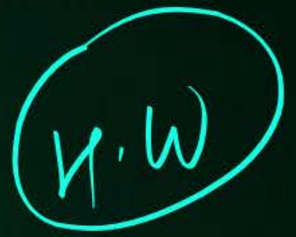
H.W

1. $F > Cl > Br > I$
2. $F < Cl < Br < I$
3. $F < Cl > Br > I$
4. $F < Cl < Br < I$

QUESTION

The elements in which electrons are progressively filled in 4f-orbital are called

1. actinoids
2. transition elements
3. lanthanoids
4. halogens



QUESTION

Which of the following is the correct order of size of the given species.

1. $I > I^- > I^+$
2. $I^+ > I^- > I$
3. $I > I^+ > I$
4. $I^- > I > I^+$

H.W

QUESTION

The element with atomic number 57 belongs to

1. s-block
2. p-block
3. d-block
4. f-block

QUESTION

The last element of the p-block in 6^{th} period is represented by the outermost electronic configuration.

1. $7s^2\ 7p^6$

2. $5f^{14}\ 6d^{10}\ 7s^2\ 7p^0$

3. $4f^{14}\ 5d^{10}\ 6s^2\ 6p^6 4f^{14}\ 5d^{10}\ 6s^2\ 6p^6$

4. $4f^{14}\ 5d^{10}\ 6s^2\ 6p^4$

H.W

QUESTION

Which of the elements whose atomic number are given below, cannot be accommodate in the present set up of the long form of the periodic table

H.W

1. 107
2. 118
3. 126
4. 102

QUESTION

The electronic configuration of the element which is just above the element with atomic number 43 in the same group is _____.

1. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5 4s^2$
2. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5 4s^3\ 4p^6$
3. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^6 4s^2$
4. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^7 4s^2$

Sc Ti V Cr Mn.
21 22 23 24 25

39 40 41 42 43 Tc

QUESTION

The element with atomic numbers 35, 53, and 85 are all _____ .

H.W

1. noble gases
2. halogens
3. heavy metals
4. light metals

QUESTION

Electronic configurations of four elements A, B, C and D are given below :

(a) $1s^2\ 2s^2\ 2p^6$ Ne

(b) $1s^2\ 2s^2\ 2p^4$ O

(c) $1s^2\ 2s^2\ 2p^6\ 3s^1$ Na

(d) $1s^2\ 2s^2\ 2p^5$ F

Which of the following is the correct order of increasing tendency to gain electron :

EA

1. a < c < b < d
2. a < b < c < d
3. d < b < c < a
4. d < a < b < c

QUESTION

Which of the following represents the correct order of increasing first ionization enthalpy for Ca, Ba, S, Se and Ar ?

[JEE Mains 2013]

1. Ba < Ca < Se < S < Ar
2. Ca < Ba < S < Se < Ar
3. Ca < S < Ba < Se < Ar
4. S < Se < Ca < Ba < Ar

Metals ⇒ I.E Low

Ca

Ba

QUESTION

The second ionization potentials in electron volts of oxygen and fluorine atoms are respectively given by :

H.W

1. 35.1, 38.3
2. 38.3, 38.3
3. 38.3, 35.1
4. 35.1, 35.1

QUESTION

Successive ionization energies of an element 'X' are given below (in kcal) :

IP_1	IP_2	IP_3	IP_4
165	195	556	595

Electronic configuration of the element X is :

H.W

1. $1s^2, 2s^2 2p^6, 3s^3 3p^2$
2. $1s^2, 2s^1$
3. $1s^2, 2s^2 2p^2$
4. $1s^2, 2s^2 2p^6, 3s^2$

QUESTION

In the process, $Cl(g) + e^- \xrightarrow{\Delta H} Cl^-(g)$, ΔH is :

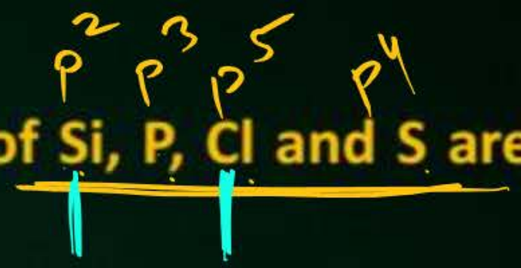
1. Positive
2. Negative
3. Zero
4. None of these

H.W

QUESTION

The correct values of ionization energies (in kJ mol^{-1}) of Si, P, Cl and S are respectively :

1. 786, 1012, 999, 1256
2. 1012, 786, 999, 1256
3. 786, 1012, 1256, 999
4. 786, 999, 1012, 1256



QUESTION

Series-I : $[N^{3-}, O^{-}, Na^{+}]$; Series-II : $[N^{+}, C^{+}, O^{+}]$

Choose the species of lowest I.P. from series-I and highest I.P. from series-II respectively :

1. N^{3-}, O^{+}
2. Na^{+}, C^{+}
3. N^{3-}, N^{+}
4. O^{-}, C^{+}

QUESTION

The first ionization potentials (eV) of Be and B respectively are :

1. 8.29 eV, 9.32 eV
2. 9.32 eV, 9.32 eV
3. 8.29 eV, 8.29 eV
4. 9.32 eV, 8.29 eV

Be > B

$2s^2 > 2p^1$

p. p

QUESTION

Match the column-I (Elements) with column-II (Configuration of elements)

	Column I		Column II
1	The third alkali metal	(D)	(P) $1s^2 2s^2 2p^6 3s^2 3p^5$
2	The second transition element	(R)	(Q) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6$
3	The fourth noble gas element	(Q)	(R) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^2 4s^2$
4	The second halogen element	(P)	(D) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$

QUESTION

Which one of the following sets of ions represents a collection of isoelectronic species?

(Given Atomic Number: F:9, Cl:17, Na = 11,Mg =12, Al =13, K=19, Ca =20, Sc = 21)

[JEE Main-2023]

H.W

1. $N^{3-}, O^{2-}, F^{-}, S^{2-}$
2. $K^{+}, Cl^{-}, Ca^{2+}, Sc^{3+}$
3. $Ba^{2+}, Sr^{2+}, K^{+}, Ca^{2+}$
4. $Li^{+}, Na^{+}, Mg^{2+}, Ca^{2+}$

QUESTION

Which of the following represents the correct order of metallic character of the given elements? [JEE Main-2023]

1. Si < Be < Mg < K
2. Be < Si < Mg < K
3. K < Mg < Be < Si
4. Be < Si < K < Mg

QUESTION

Element having maximum EN is :

1. Li
2. Be
3. C
4. O

H.W

QUESTION

Ionization energy of nitrogen is more than oxygen due to :

1. Increased attraction of electron towards nucleus

H.W

2. Extra stability of half filled 'p' orbital

3. Small size of N_2

4. None of the above

QUESTION

In the general electronic configuration -
$(n-2)f^{1-14}\ (n-1)d^{0-1}\ ns^2$, if value of n = 7 the configuration will be of -

1. Lanthenides
2. Actinides
3. Transition elements
4. None

QUESTION

The radius of potassium atom is 0.203 nm. The radius of the potassium ion in nanometer will be :

1. 0.133
2. 0.231
3. 0.234
4. 0.251

$K = 0.203$

$K^+ = ?$

$K > K^+$

QUESTION

The best reason to account for the general tendency of atomic diameters to decrease as the atomic numbers increase within a period of the periodic table is the fact that :

1. Outer electrons repel inner electrons

H.W

2. Closer packing among the nuclear particles is achieved

3. The number of neutrons increases

4. The increasing nuclear charge exerts a greater attractive force on the electrons

QUESTION

Which of the following transitions involves maximum energy ?

1. $M^-(g) \rightarrow M(g)$
2. $M^{2+}(g) \rightarrow M^{3+}(g)$
3. $M^+(g) \rightarrow M^{2+}(g)$
4. $M(g) \rightarrow M^+(g)$

$M^- \xrightarrow{\varepsilon_1} M \xrightarrow{\varepsilon_2} M^+ \xrightarrow{\varepsilon_3} M^{2+} \xrightarrow{\varepsilon_4} M^{3+}$

$\varepsilon_1 < \varepsilon_2 < \varepsilon_3 < \varepsilon_4$

QUESTION

In which case, the energy is not released ?

1. $Cl \rightarrow Cl^-$
2. $P \rightarrow P^-$
3. $N \rightarrow N^-$
4. $C \rightarrow C^-$

QUESTION

The radius of isoelectronic series :

1. Decreases with decreasing nuclear charge

H.W

2. Decreases with increasing effective nuclear charge

3. Same for all

4. First increases then decreses

QUESTION

The correct order of size for oxygen, species O, O^-, O^+ is :

1. $O > O^- > O^+$
2. $O > O^+ > O^-$
3. $O^+ > O^- > O$
4. $O^- > O > O^+$

H.W

QUESTION

A neutral atom (Ar) is converted to (A^{3+}) by the following process

$$Ar \xrightarrow[-e]{E_1} Ar^{+} \xrightarrow[-e]{E_2} Ar^{2+} \xrightarrow[-e]{E_3} Ar^{3+}$$

The correct order of E_1, E_2 and E_3 energies is :

1. $E_1 < E_2 < E_3$
2. $E_1 > E_2 > E_3$
3. $E_1 = E_2 = E_3$
4. $E_1 > E_2 < E_3$

H.W

QUESTION

Assign true (T) or false (F) for following statements and select correct option for your answer.

(i) I.P. of $O_{(g)}$ is less than I.P. of $O^-_{(g)}$

(ii) I.P. of $Ne_{(g)}$ is greater than I.P. of $Ne^+_{(g)}$

(iii) E.A. of $O^+_{(g)}$ is greater than E.A. of $O_{(g)}$

(iv) I.P. of $N_{(g)}$ is greater than I.P. of $N^+_{(g)}$

$O < O^-$ X

$Ne > Ne^+$ X

$O^+ > O$ ✓

$N > N^+$ X

1. F, F, T, F
2. T, T, T, T
3. T, T, T, F
4. F, T, F, T

QUESTION

The electronic configuration of four element are :

(i) $[Xe]6s^2$ (ii) $[Xe]4f_{14}5d_16s^2$

(iii) $[Ar]3d^{10}4s^24p^5$ (iv) $[Ar]3d^74s^2$

Which one of the following statements about these elements is not true ?

1. (i) is a strong reducing agent
2. (ii) is a d-block element
3. (iii) has high negative electron gain enthalpy
4. (iv) Show variable oxidation states

QUESTION

The correct electron affinity order of N, O, S, Cl is :

1. O < N < Cl < S
2. Cl > O > S > N
3. N < O < S < Cl
4. N = Cl > O = S

QUESTION

Match the matrix.

	Column-I (Decreasing order)	Column-II (Correct for)
1	I > Br > Cl > F	(P) Fist ionization energy
2	F > Cl > Br > I	(Q) Size
3	Cl > F > Br > I	(R) EA (electron affinity)
4	O > F > N > C	(S) EN (electronegativity)
		(T) Second ionization energy

Revision

Mind Map Series

Homework

Ques from Module

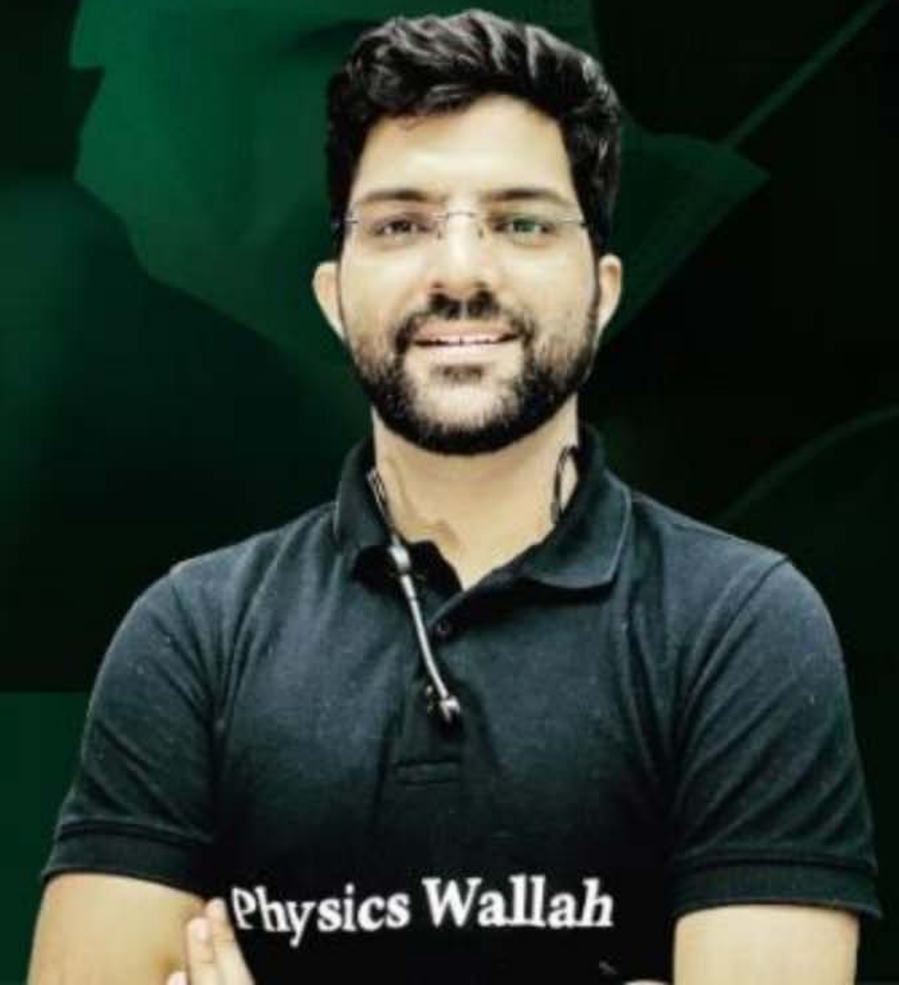
THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture - 01 | Inorganic Chemistry

Chemical Bonding and Molecular Structure



By - Mohit Dadheech (MD Sir)

Topics *to be covered*

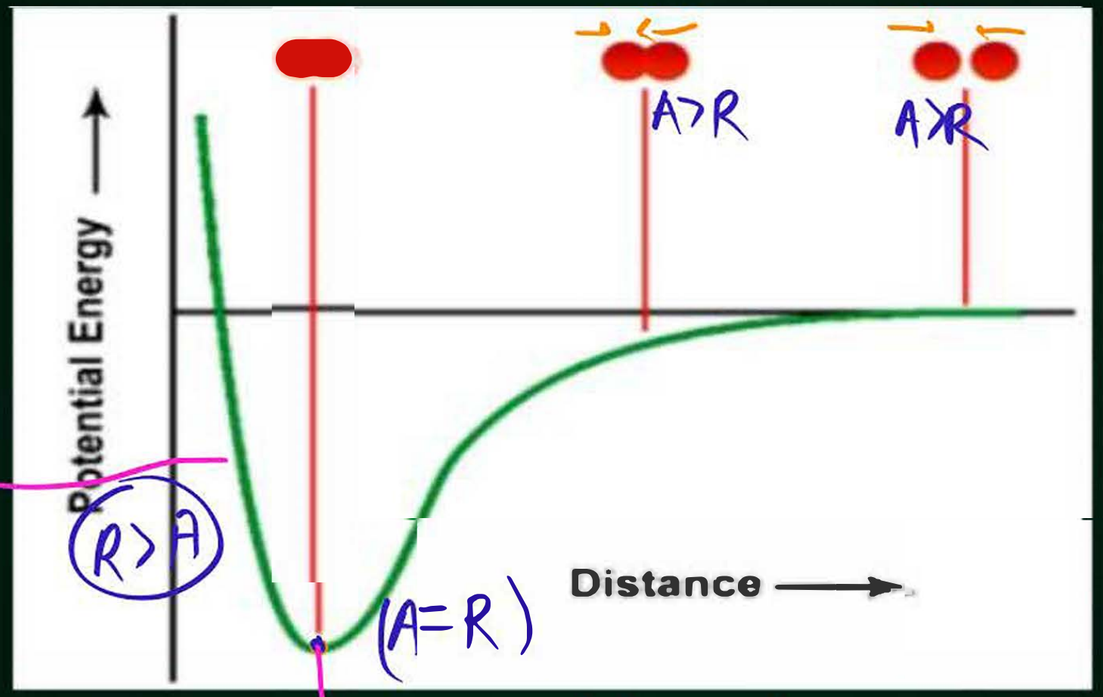
1. Introduction
2. Octet Rule
3. Formal charge

Chemical Bond :

Force of attraction present between any chemical species like atoms, ions, Molecules.

Bond formation is → Exothermic
Energy Release.

Bond dissociation → Endothermic
Energy absorb



Bond dissociation

Bond formation point
Minimum potential Energy

Why do atoms Combine?

(i) To achieve Stable outer Octet

$8e^-$

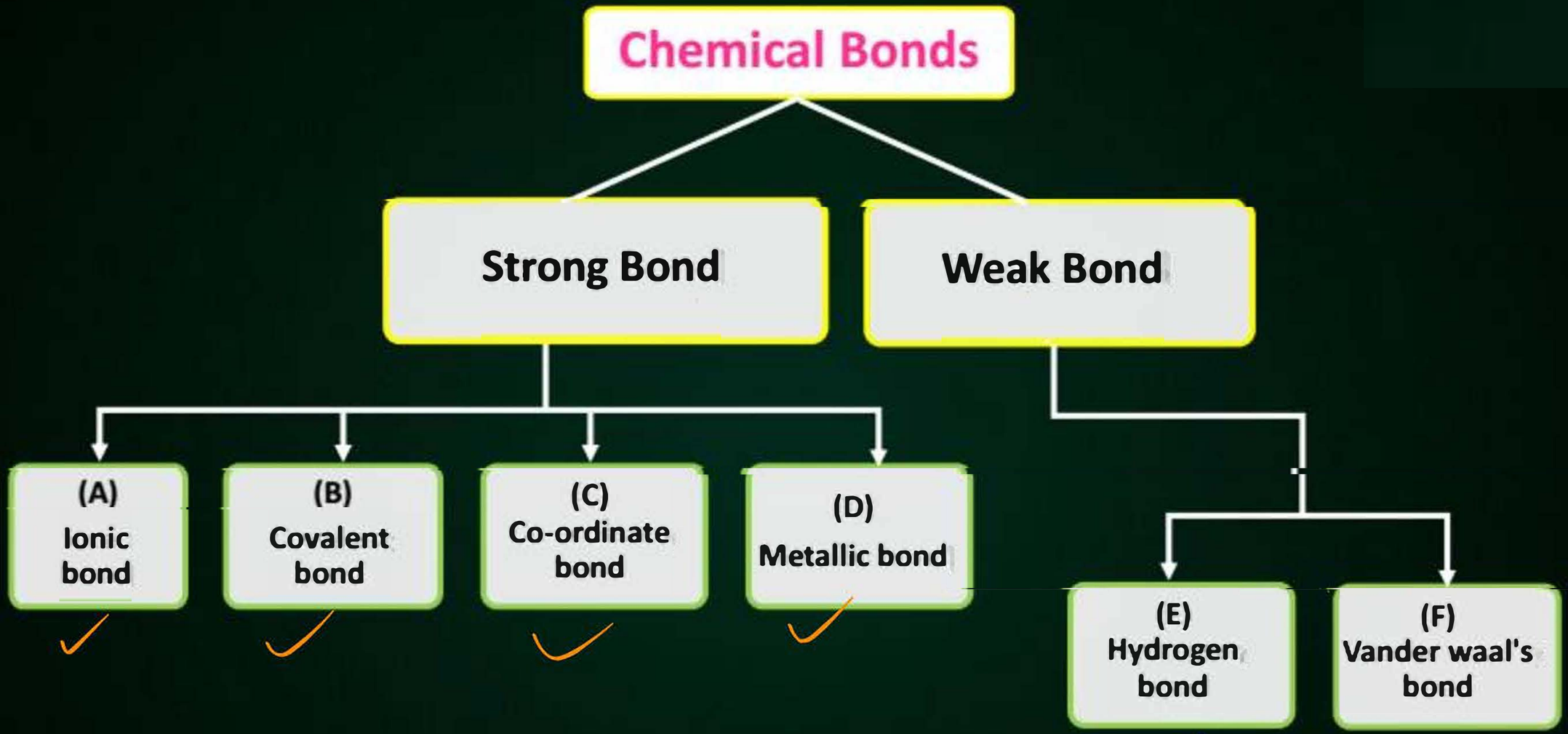
Classical Concept

$s^2 p^6$ configuration in Valence shell

$8e^-$

(ii) To achieve Minimum potential Energy State & Maximum Stability

Modern Concept


Chemical Bonds
Strong Bond
Weak Bond
(A)
Ionic bond
(B)
Covalent bond
(C)
Co-ordinate bond
(D)
Metallic bond
(E)
Hydrogen bond
(F)
Vander waal's bond

Kossel-Lewis Approach (Octet Rule) :

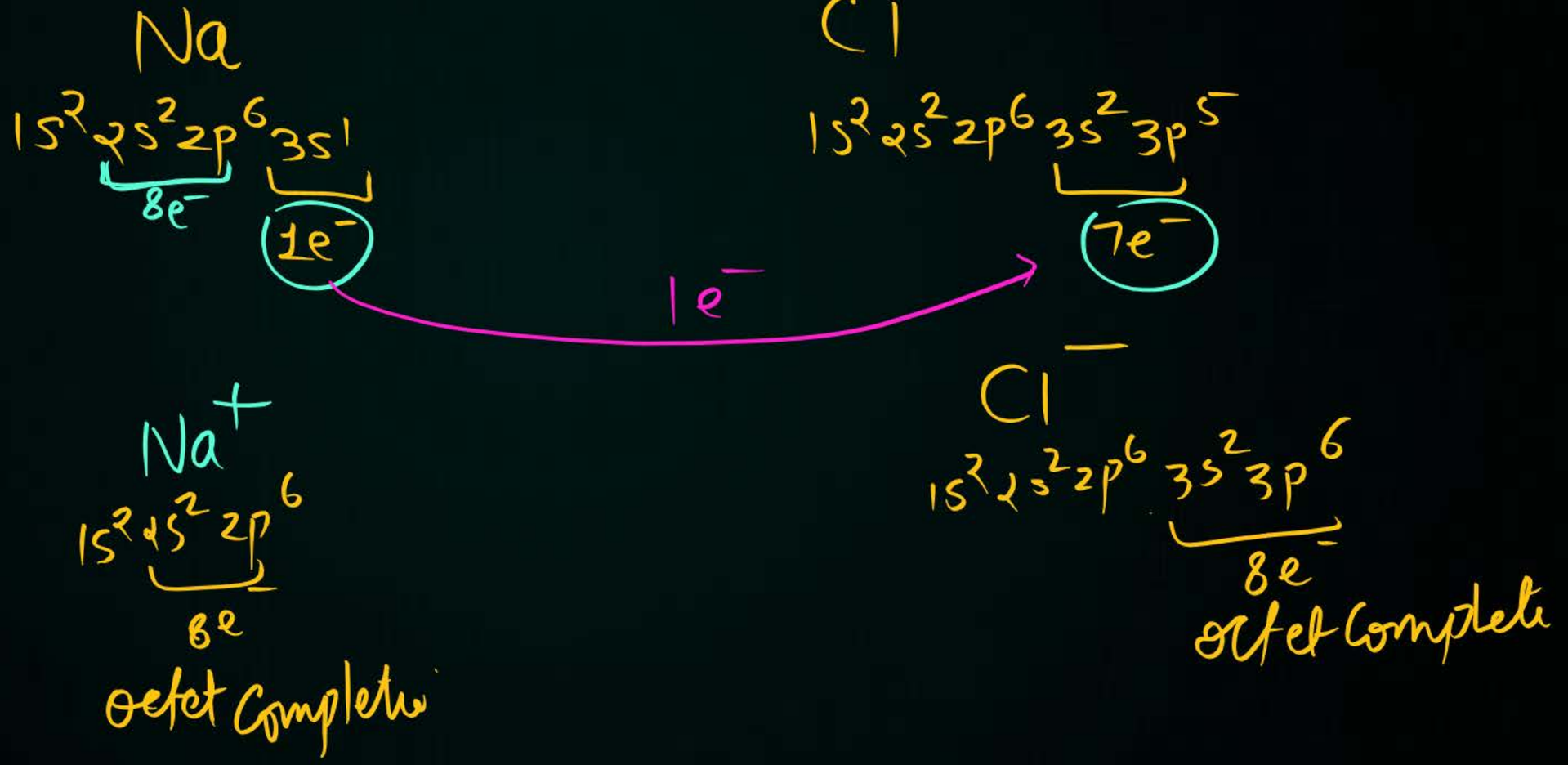
- It was based on inertness of noble gases. → $ns^2 np^6$ → $8e^-$
- Atoms can combine either by transfer of valence electrons from one atom to another (gaining or losing) or by sharing of valence electrons in order to have an octet (8 e^- in their valence shells.)
- In case of H & He duplet (2 e^- in valence shell) will be completed.

(1s) → Max $2e^-$

Lewis symbols :

Valence e^-	1	2	3	4	5	6	7	8
	$2s^1$	$2s^2$	$2s^2 2p^1$	$2s^2 2p^2$	$2s^2 2p^3$	$2s^2 2p^4$	$2s^2 2p^5$	$2s^2 2p^6$

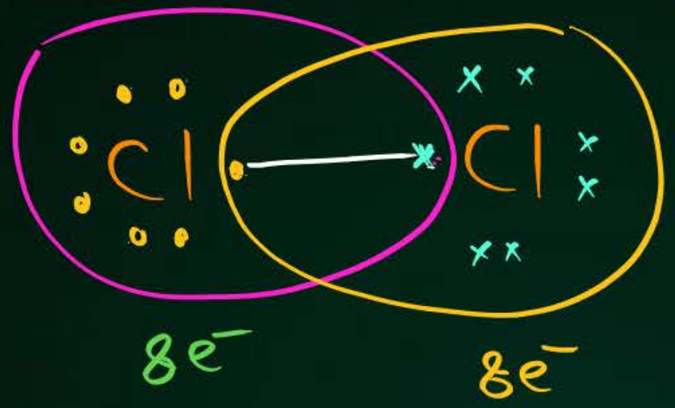
Ex octet Completion by transfer of e^-



Formation of the Cl_2, O_2, N_2 molecules :

(Ex) octet Completion by Sharing of e^-

(1) Cl_2



Bond pair $= \frac{\text{Bonding } e^-}{2}$ No. of shared e^- (Bonding e^-) $\rightarrow$ 2

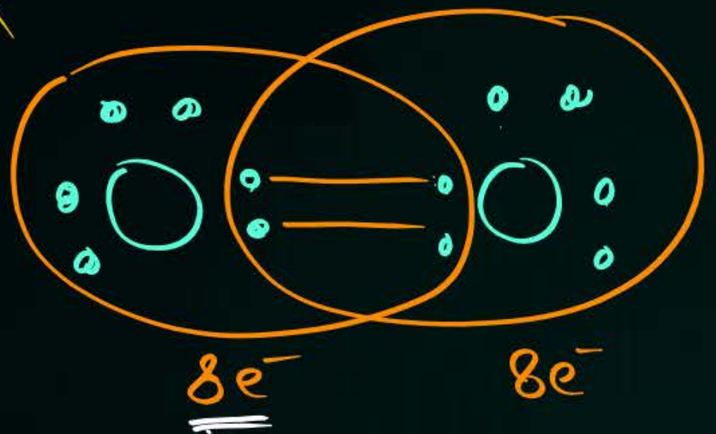
no. of non-Bonding $e^- \Rightarrow 12$

lone pair or Non Bonding pair $= \frac{12}{2} = 6$

$$\text{no. of Bonds} = \frac{\text{no. of Bonding } e^-}{2}$$

Bond pairs / no. of Bonds

(2) O_2

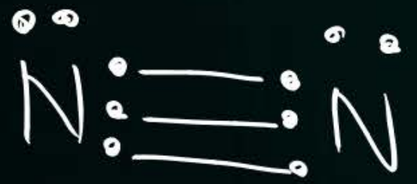


Bonding + non Bonding

Bond pairs — 2

lone pairs 4

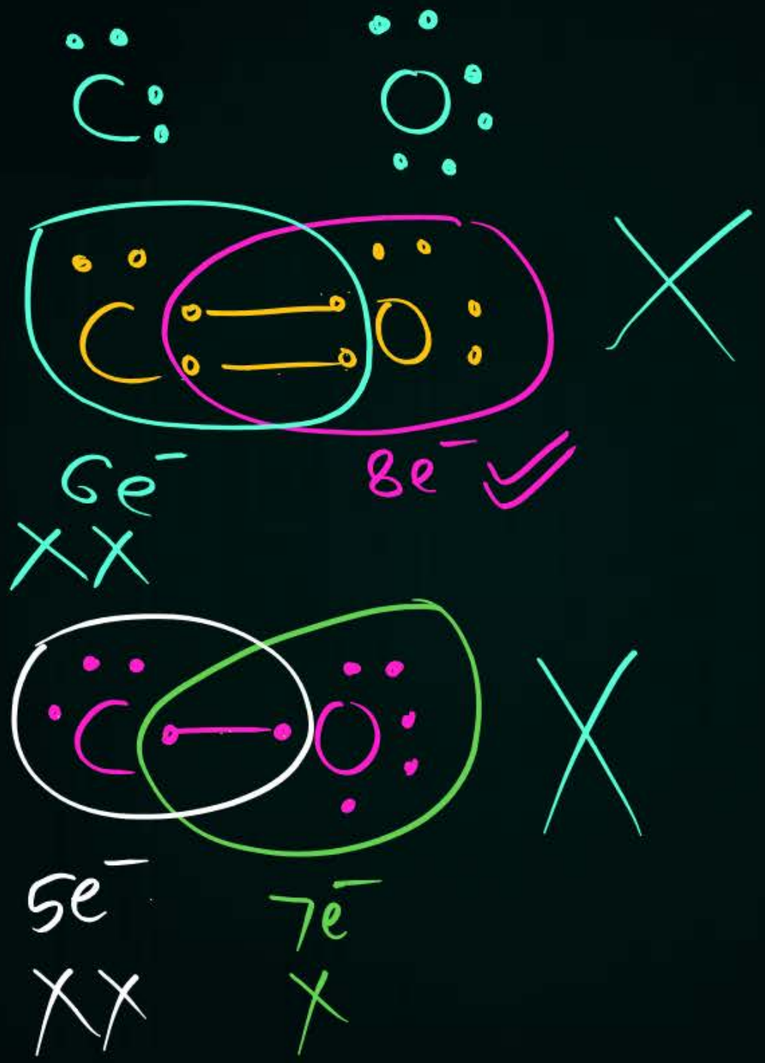
(3)

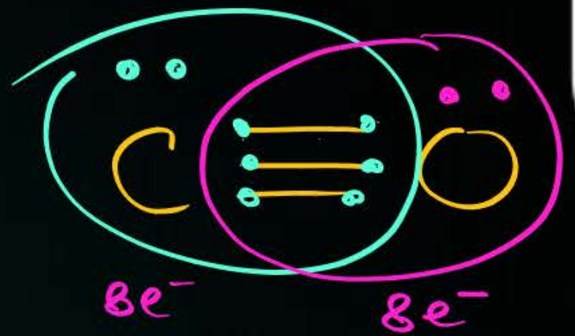


Bond pairs :— 3

lone pairs :— 2

(4) CO





How to write Lewis dot structure :

MDJ

$$\text{No. of Bonds} = \frac{\text{no. of Req. Valence } e^- \text{ (always 8)} - \text{no. of available Valence } e^-}{2}$$

For CO

$$\frac{(8+8) \quad (4+6)}{2} \quad \frac{16 - 10}{2} = \frac{6}{2} = 3 \text{ Bonds}$$

$\ddot{C} \equiv \ddot{O}$

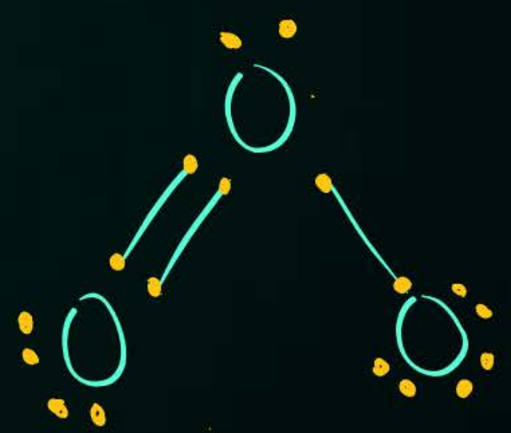
Ex O_3

$(8+8+8)$ $(6+6+6)$

$$\text{no. of Bonds} = \frac{24 - 18}{2}$$

$$\frac{6}{2} = 3$$

no. of Bonds



(3) CO_2 $\quad 8+8+8 \quad (4+6+6)$

$$= \frac{24 - 16}{2} = (4)$$ Bonds

(A)

(B)

(4) N_3^-

$(8+8+8)$ $(5+5+5+1)$

-ve charge → Extra available e^-

$$\frac{24 - 16}{2} = 4 \text{ Bonds}$$

(A)

(B)

Formal charge

(M D'J)

F.C = Jitne Hone Chahiye — Jitne Hai

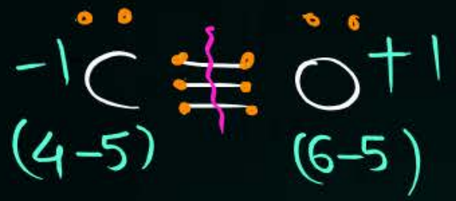
charge present on an atom in a molecule due to gain or loss of e^-

Valence e^- in Free state of atom

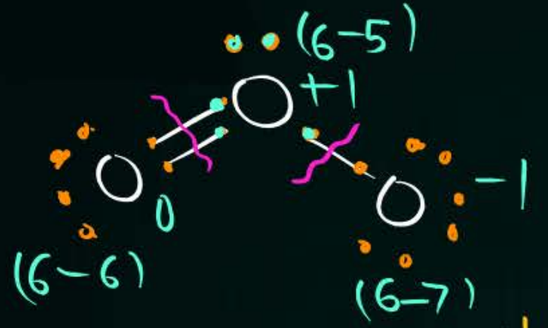
(Ex) O = 6
C = 4
N = 5
B = 3

Valence e^- in given Lewis dot structure.

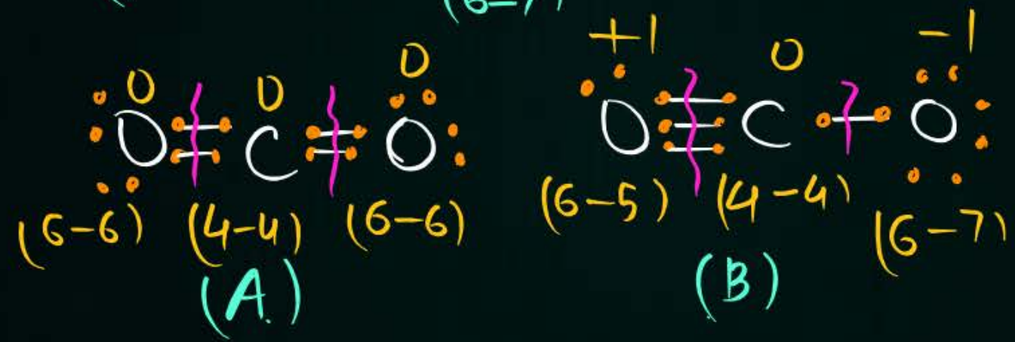
(1) CO



(2) O_3

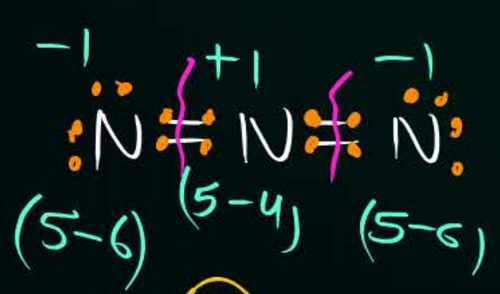


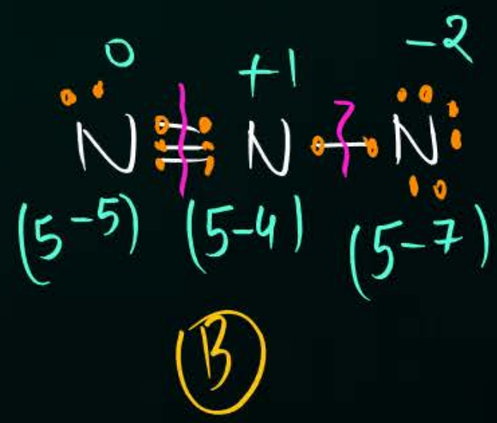
(3) CO_2



(A) is more stable due to absence of charge.

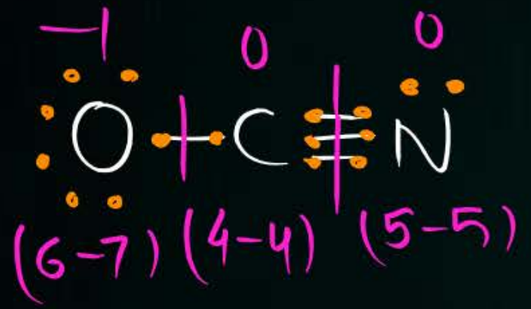
(4) N_3^-

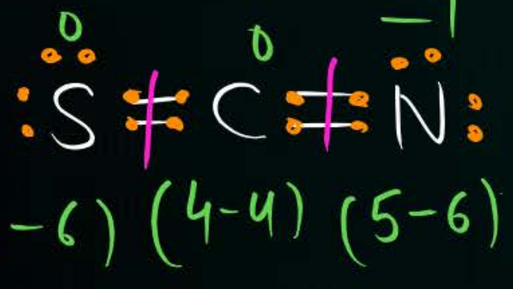




(A) is more stable due to symmetrical charge distribution.

(5) CN^- Cyanide ion.

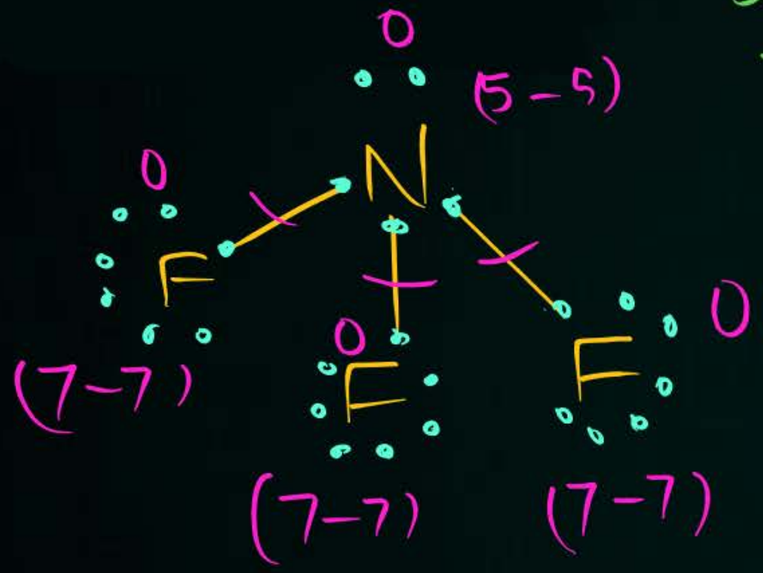
(6)  OCN^- Cyanate ion

(7)  SCN^- thiocyanate ion.

NF_3

$8 \times 4 \qquad 5 + 7 \times 3$

$$\frac{32 \text{ — } 26}{2} = \frac{6}{2} = 3$$



THANK YOU

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FOR NEET 2025

Lecture - 02 | Inorganic Chemistry

Chemical Bonding and Molecular Structure

By - Mohit Dadheech (MD Sir)

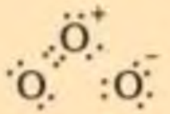
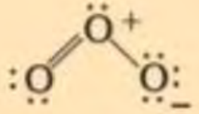
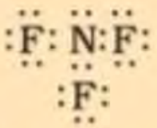
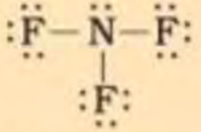
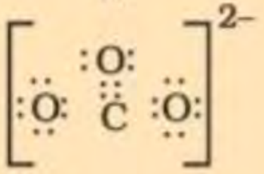
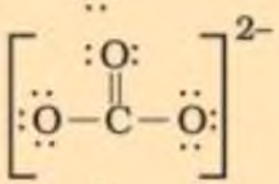
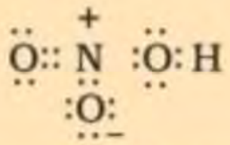
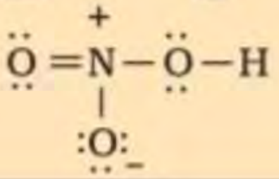
Topics *to be covered*

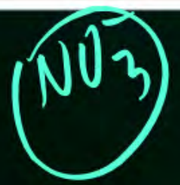
1. Formal Charge
2. Average formal charge in some important Oxo-anions
3. Coordinate Bond

Formal Charge :

Formal charge (F.C.) on an atom in a Lewis structure = [Total number of valence electrons in the free atom] − [total number of non bonding (lone pair) electrons] − 1/2 [total number of bonding(shared) electrons]

Examples given in NCERT

Molecule/Ion	Lewis Representation	
H_2	H : H*	H – H
O_2	:Ö::Ö:	:Ö=Ö:
O_3		
NF_3		
CO_3^{2-}		
HNO_3		



Limitations of Octet Rule :

(i) Existence of Hypervalent Compound → Valence e^- at central atom > 8

(ii) Existence of Hypovalent Compound → Valence e^- < 8

(iii) Odd electron species do not follow octet rule NO, NO_2

(iv) Existence of Compounds of inert gases with Oxygen & Fluorine like XeF_2, KrF_2, $XeOF_2$ etc.

(v) It does not explain the relative stability of the molecules being totally silent about the energy of a molecule.

(vi) This theory does not account for the shape of molecules.

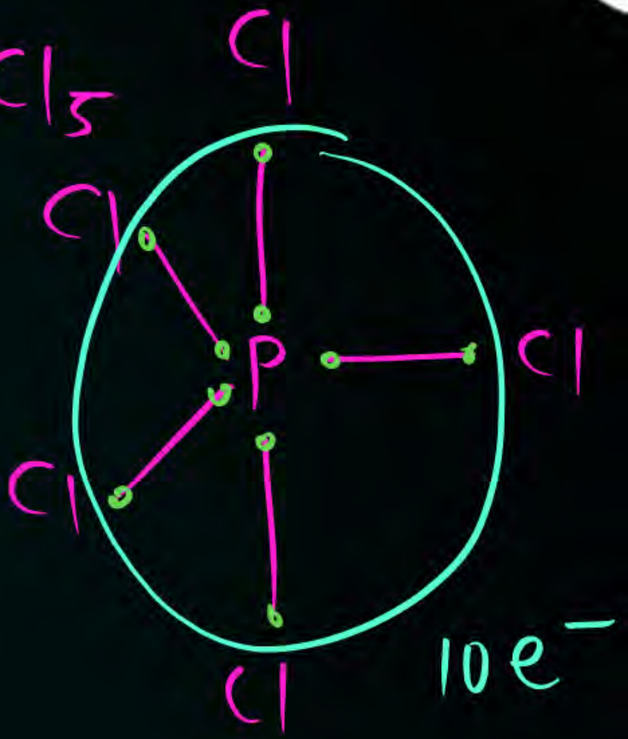
⇒ Hypervalent / Expended octet /

Valence $e^- > 8$

Ex SF_6

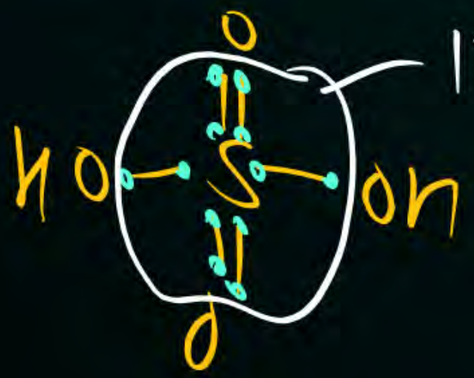
12 e^-

PCl_5



10 e^-

H_2SO_4

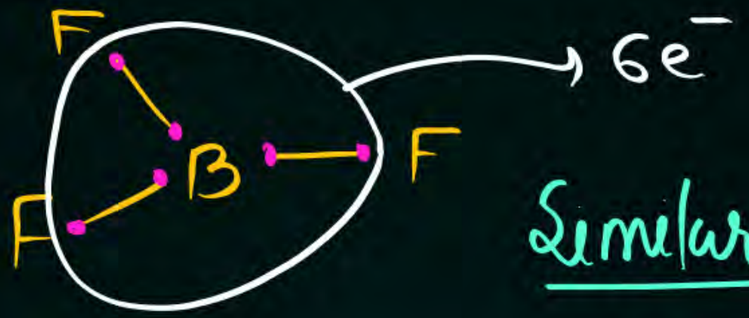


12 e^-

⇒ Hypovalent

Valence e^- < 8 → electron deficient Compounds

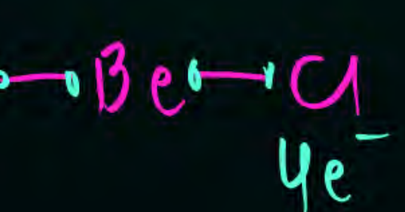
(1) BF_3



Similar Ex. BCl_3, BBr_3, BI_3
BH_3, B_2H_6

LiCl

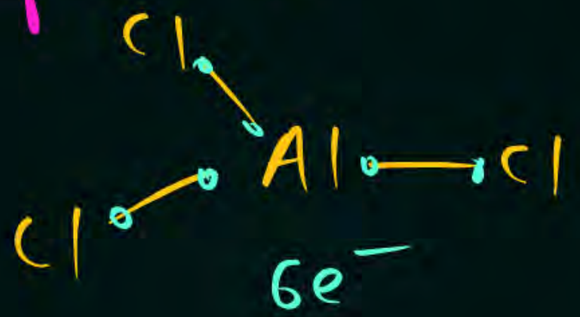
$BeCl_2$



AlF_3 → e⁻ ~~deficient~~ ∵ AlF_3 ionic Compounds.

Al^{3+} } $3F^-$

$AlCl_3$ → e⁻ deficient ✓



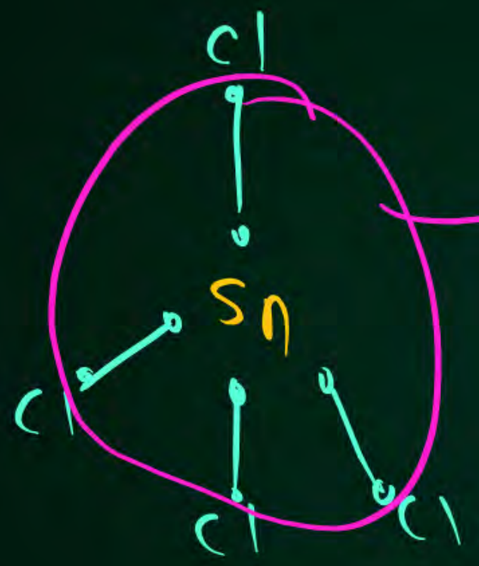
Al^{3+} $1s^2 \underbrace{2s^2 2p^6}_{8e^-}$

F^- $1s^2 \underbrace{2s^2 2p^6}_{8e^-}$

QUESTION

Which is not an exception to octet rule ?

1. BF_3 hypo.
2. $SnCl_4$
3. BeI_2 hypo.
4. PCl_5 hyper



8e⁻

octet complete

odd e^- Species :-

(i) NO

$7e^-$

(ii) NO_2

$7e^-$

Some more Ex. of odd e^- species :-

ClO_2

ClO_3

CH_3

CF_3

Some imp points

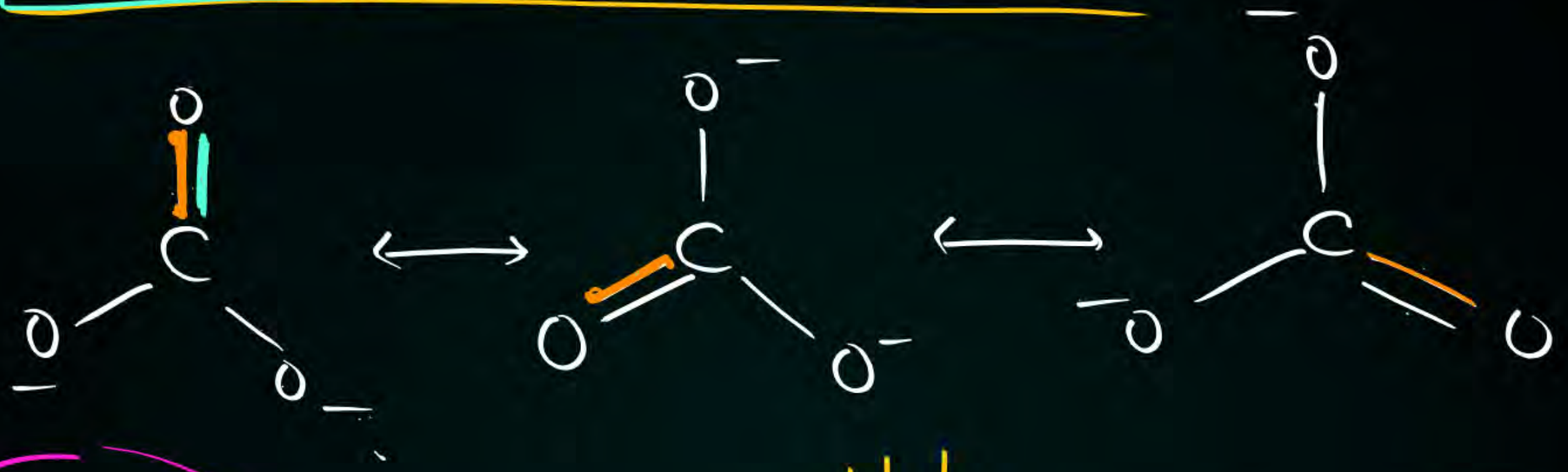
(i) Lewis Acid :- e^- pair Acceptor.
(e deficient Ex BF_3)
→ gen. hypovalent species

(ii) Lewis Base :- e^- pair donar
e^- Rich Compounds.

Ex NH_3

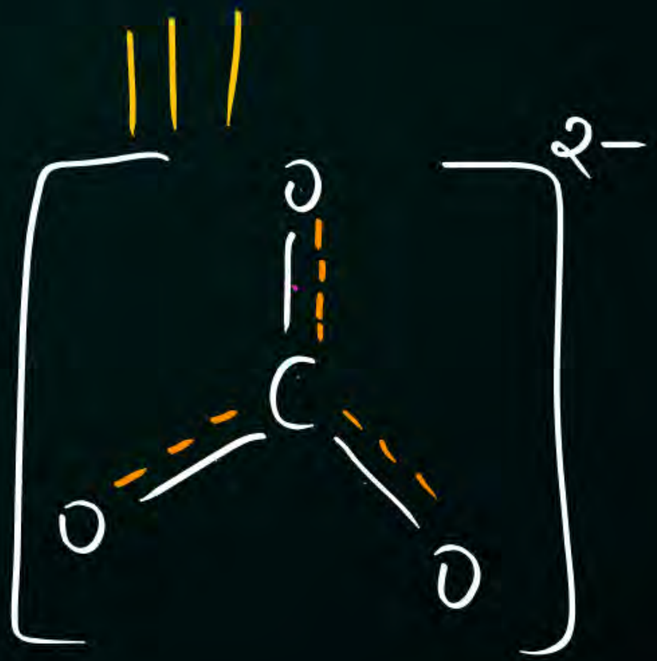
8 e^-
octet Complete
l.p available
Can work as
Lewis Base

Resonance in CO_3^{2-} (carbonate ion)



$\frac{4}{3} = 1.33$

Avg. F.C on oxygen $\frac{-2}{3}$



Avg Bond Order

$1 + \frac{1}{3} = 1.33$

Avg. Formal Charge & Avg. X-O Bond order in Oxo-anions :

surrounding atoms oxygen.

$$\text{Avg. F.C} = \frac{\text{Total Charge Present of oxygen atom}}{\text{Number of oxygen atom where negative charge can be placed}}$$

on oxygen

$$\text{Avg. X-O bond order} = \frac{\text{Total number of X-O bonds}}{\text{Number of X-O pairs participate in resonance}}$$

SO_4^{2-}

NO_3^-

NO_2^-

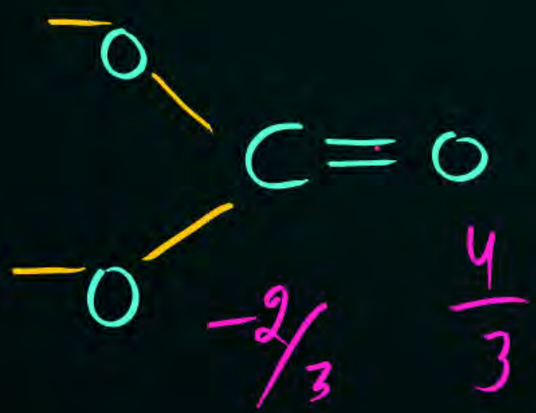
ClO_3^- SO_3^{2-}

ClO_4^-

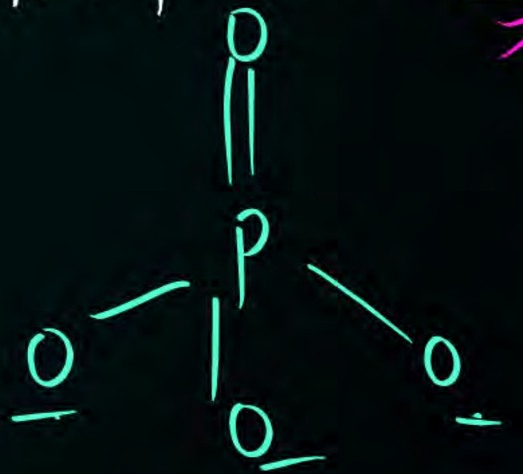
MDJ

	F.C
$-\ddot{O}$	-1
$=O$ or $-O-$	0
$\equiv O$ or $=O-$	$+1$

(i) CO_3^{2-}

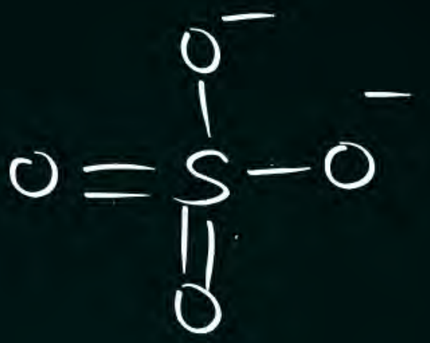
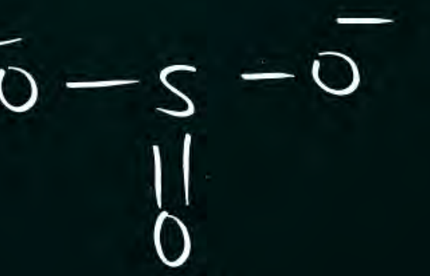
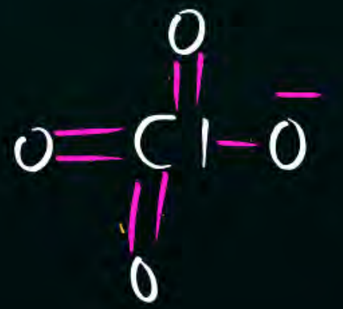


(ii) PO_4^{3-} phosphate.



$-3/4$ Avg F.C

5/4 Avg B.O

			Avg F.Con "O"	Avg B.O
(iii)	NO_2^- Nitrite ion		$-1/2$	$3/2$
(iv)	SO_4^{2-} Sulphate ion		$-2/4$	$6/4$
(v)	SO_3^{2-} Sulphite ion		$-2/3$	$4/3$
(vi)	ClO_4^- Perchlorate ion		$-1/4$	$7/4$

H.W ClO_3^-

ClO_2^-

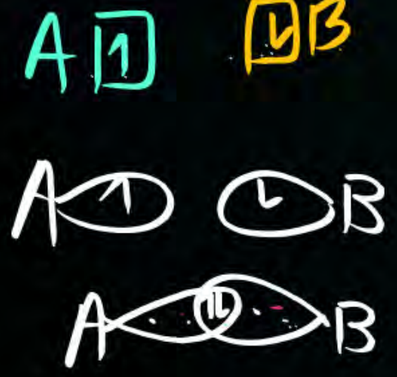
"Covalent Bond"

Sharing of e^-

Simple Covalent

Equal sharing

A — B



Coordinate Covalent Bond

Unequal sharing

A : → B

donor acceptor

A → B

or

A^+ — $\bar{B}$

① Coordinate covalent

② Covalency

③ Overlapping

Defination

* Merging of orbitals
* Mechanism of Covalent Bond Formation

Covalency

Combining Capacity of an atom in given covalent Compound.

MDJ No. of $\sigma + \pi$ Bonds.

Ex

Covalency of C $\Rightarrow$ 4

Ex

Covalency of C = 4

Covalency of H = 1

BF_3 Covalency of B = 3

Covalency of F = 1

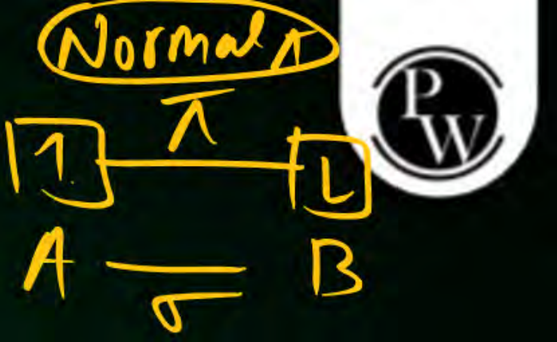
CO_2 O=C=O Covalency of C = 4

Covalency of O = 2

PCl_5 Covalency of P = 5

Covalency of Cl = 1

Coordinate Bond :



Formed by the unequal sharing of e^-.

Coordinate bond is formed b/w e^- donor & e^- acceptor.

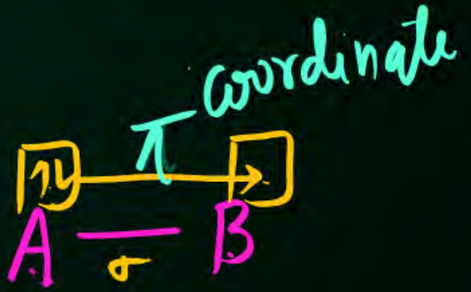
It can not be distinguish from covalent bond after formation.

Coordinate Bond

- σ Coordinate Included in covalency

A → B
σ Coordinate

- π coordinate weak Bond (Back Bond) Not included in Covalency



A ⟹ B

⇒ Species having σ Coordinate / Dative Bond

1. PH_4^+
2. NH_4^+
3. $NH_3 \cdot BF_3$
4. PCl_6^-
5. BF_4^-
6. O_3
7. NO_2
8. NO_3^-
9. H_3O^+
16. BH_4^-
11. $AlCl_4^-$

and all Complex Compounds or Coordination Compounds

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FOR NEET 2025

Lecture - 03 | Inorganic Chemistry

Chemical Bonding And Molecular Structure

By - Mohit Dadheech (MD Sir)

Topics *to be covered*

1. Covalent Bond, Coordinate Bond
2. Covalency of B, N, P

Covalent Bond :

"Bond formed by the equal sharing of e^-"

Covalency : "Total number of covalent bond (σ & π) formed by an atom in a molecule".

NOTE : Maximum covalency of second period element can not be more than 4 due to absence of d-orbitals.

Li	Be	B	C	N	O	F
$2s^1$	$2s^2$	$2s^2 2p^1$				

$1s^2 \; 2s^2 \; 2p$

↓ valence shell = (2)

$n = 2$

$l = ?$

$(l = 0 \text{ to } n-1)$

$l = 0, 1$

$s \quad p$

For 2nd period

Valence shell

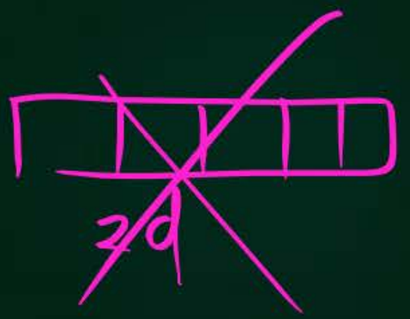
(MDJ)

2nd period Vale 4 se Jyada Bond nahi Banaskate.

(A)

∴ 4 orbitals present

So maximum Four Bonds Can be formed



O & F Can not show 4 Covalency.

F → always one.

O → gen 1 & 2

(NOTE) → [All 2nd period elements have max Four Covalency (F)]

max Covalency of 2nd period element can be four (T)

$n=3$ → 3rd period

$l = 0, 1, 2$

s, p, d

Valence shell

Na: $[Ne]\,3s^1\,3p^0\,3d^0$ Mg: $[Ne]\,3s^2\,3p^0\,3d^0$ Al: $3s^2\,3p^1\,3d^0$ Si P S Cl

$3d^0$

Vacant 3d orbitals are present in valence shell.

Vacant 3d orbitals are available for bonding.

So 3rd period element can extend their covalency beyond four.

QUESTION

Which of the following species do not exist :

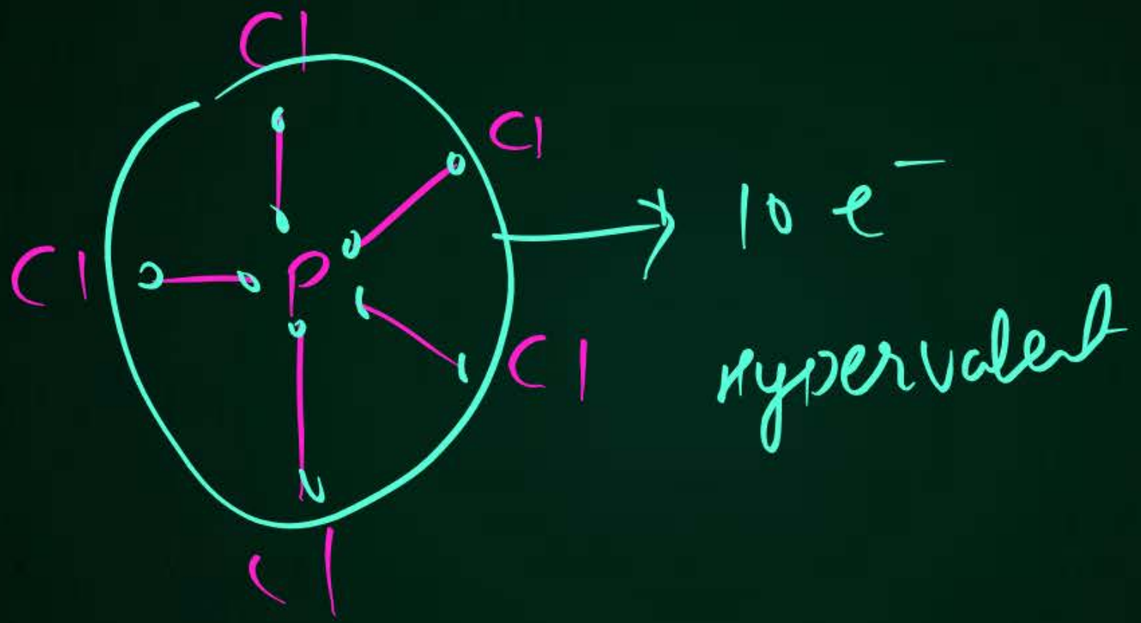
1. BF_6^{3-} (B → 2nd period)
2. SiF_6^{2-} (Si)
3. PCl_6^- (P)
4. AlF_6^{3-} (Al)

(2, 3, 4 → 3rd Period)

QUESTION

Which of the following species does not obey octet rule ?

1. SiF_4
2. PCl_5
3. ICl_2^+
4. BF_4^-



Covalency of B

(B) $1s^2 2s^2 2p^1$

(1)

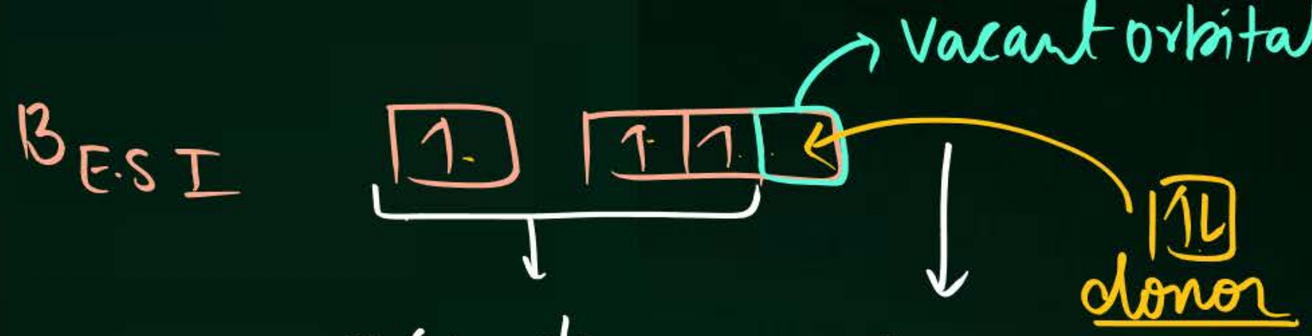
$B_{G.S}$

$B_{E.S-I}$

3 Bonds
equalsharing $\Rightarrow$ Covalency $= 3$

(Ex) BF_3, BCl_3, BBr_3

$B(OH)_3$
or
H_3BO_3



Covalency = 4 Ex BH_4^-, BF_4^-, $B(OH)_4^-$

l.p acceptor

✓ Lewis Acid

Normal covalency of (B) is three But it can be four in presence of 1 σ Coordinate Bond.

Covalency of N

$1s^2 2s^2 2p^3$

H 1s¹ ↑

H^+ 1s ☐

$N_{G.S}$ ↑↓ ↑ ↑ ↑

3 Covalency

NH_3, NF_3, NCl_3, NBr_3 etc

acceptor

Vacant orbital

Lewis Base

donor

↑↓ ↑ ↑ ↑

1 σ coordinate by donating l.p

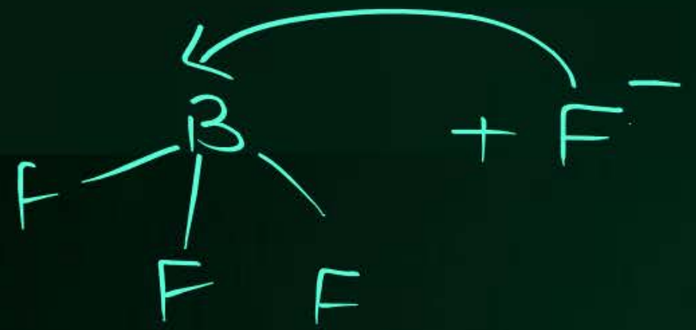
3 simple Covalent

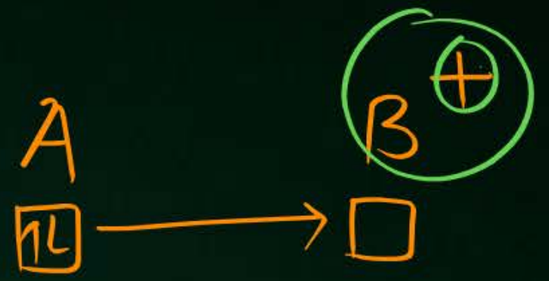
Covalency 4

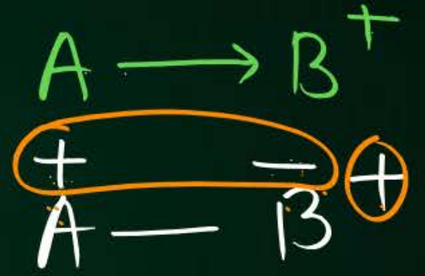
Ex NH_4^+

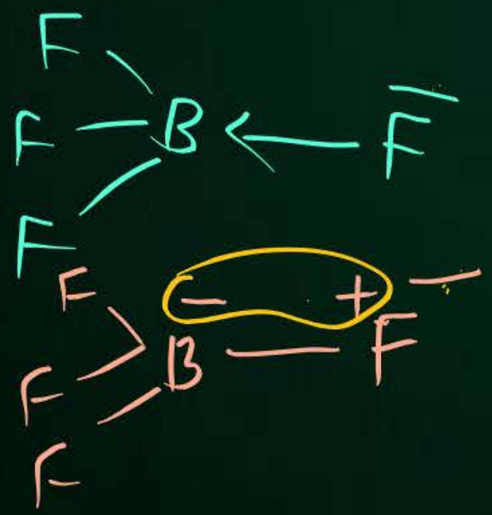
Ex ↑↓ ↑ ↑ ↑ + H^+ → NH_4^+ ammonium ion.

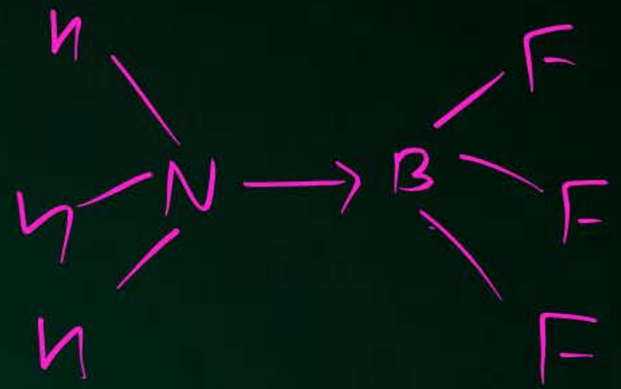
L.B

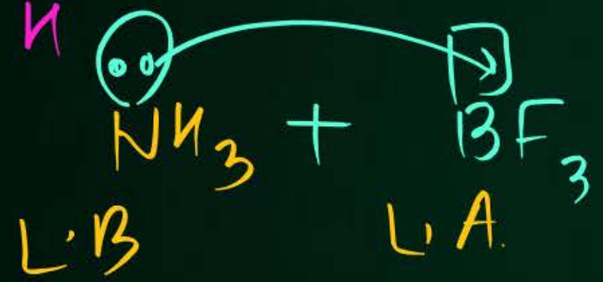

B
F
F
F
+ F −


A
B +


A → B +
A — B +


F
F
F
B
F
F
F
B
F
F
F





$$NH_3 + BF_3 \longrightarrow H_3N \longrightarrow BF_3$$

L·B L·A

$$H_3N^{+}—\overline{B}F_3$$

Covalency of (P) 3rd period

$[Ne]\ 3s^2\ 3p^3\ 3d^0$

$P_{G.S}$

Covalency = 3

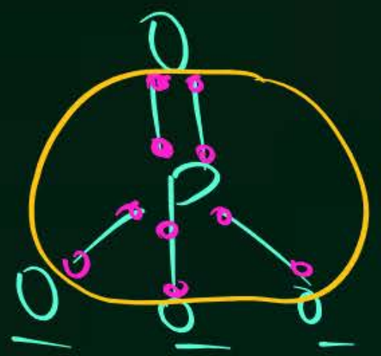
Ex PCl_3, PH_3, PF_3 etc.

$P_{E.S-I}$

5 covalency

Ex PCl_5, PBr_5, PF_5

PO_4^{3-}



10 e^-

Hypervalent

$(8+8+8+8+8) - (5+6\times4+3)$

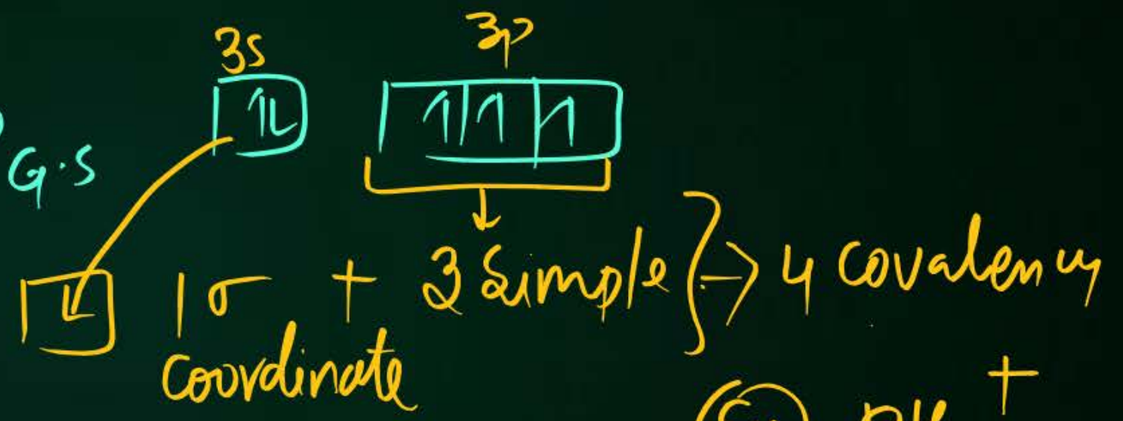
$40 - 32$

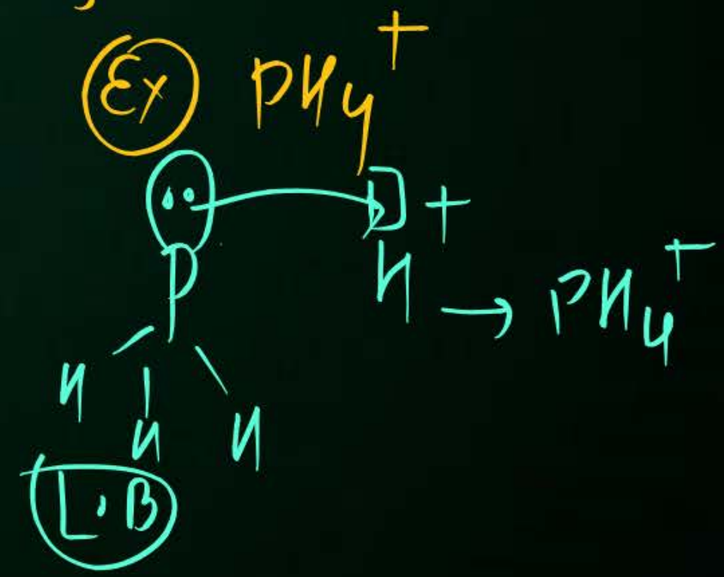
$\frac{40-32}{2} = \frac{8}{2} = 4$

Normal Covalency of P is 3 & 5

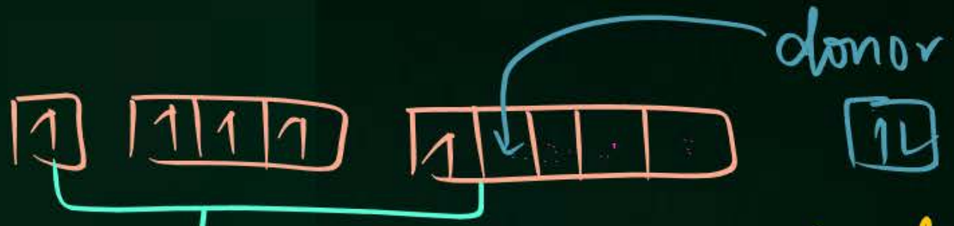
But it can be (four) & (six) in presence of σ Coordinate Bonds

Four Covalency





$P_{E.S-I}$



5 simple Covalent + 1 σ Coordinate By accepting l.p

Covalency = 6

(Ex) $PCl_5 + Cl^- \longrightarrow PCl_6^-$

$PCl_5 + Cl^-$

QUESTION

Which of the following species can behave as Lewis Base ?

l.p donar

1. BF_3
2. CCl_4
3. NH_4^+
4. PH_3 ✓

QUESTION

Which trihalide ion is unknown due to absence of vacant d-orbital ?

1. F_3^-

2. Br_3^-

3. I_3^-

4. Cl_3^-

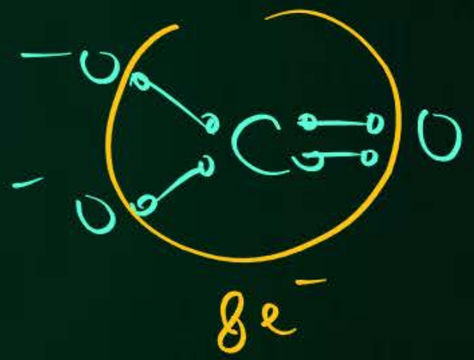
QUESTION

Which of the following species are hypervalent ?

(I) ClO_4^- (II) BF_3 (III) SO_4^{2-} (IV) CO_3^{2-}

Hyper Hypo Hyper 8e⁻ octet ✓

1. I, II, III
2. I, III ✓
3. III, IV
4. I, III, IV



QUESTION

Incorrect statement about nitrogen is :

1. General covalency = 3
2. Maximum covalency = 4
3. Maximum oxidation state = +5
4. None of these

$(+5)$ NO_3^-, N_2O_5,

Homework

(1) ↳ show, 2, 4, & 6 Covalency of S

(2) show 1, 3, 5, 7 Covalency of Cl

(3) show 2, 4, 6 Covalency of Xe.

(4) In which E.S of Xe, Compound XeF_6 will be Formed?

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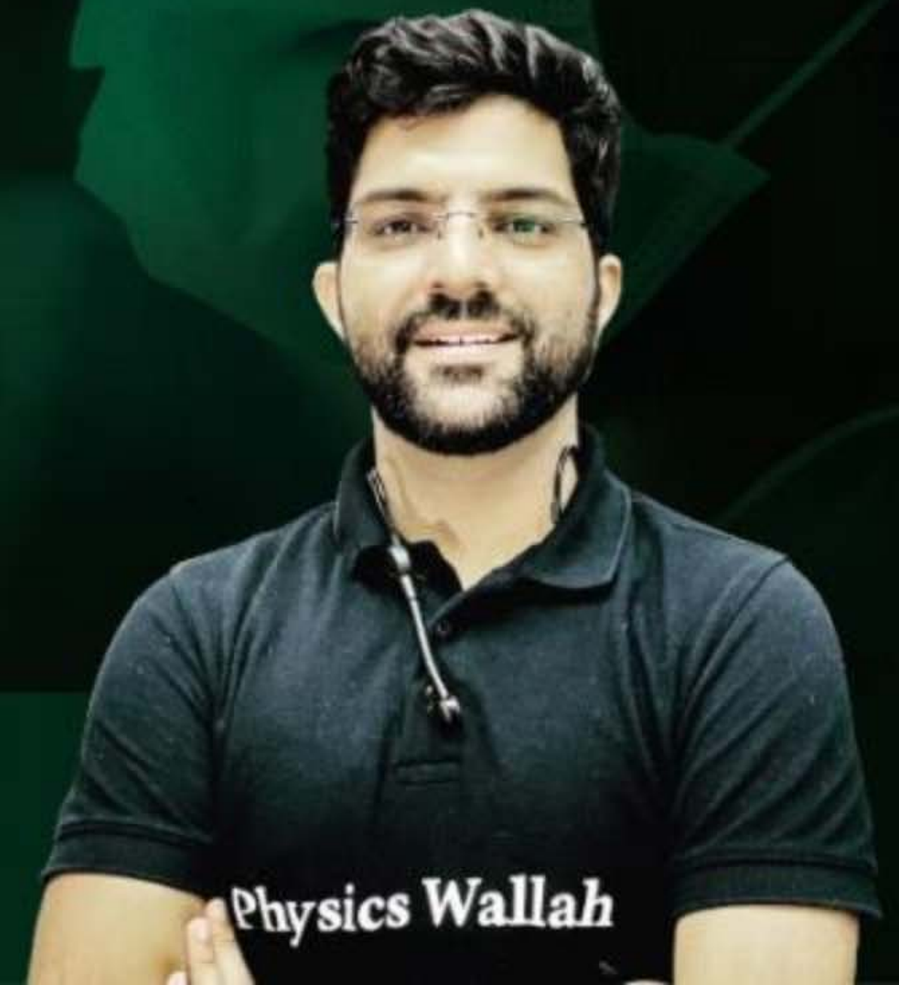
FOR NEET 2025

Lecture - 04 | Inorganic Chemistry

Chemical Bonding & Molecular Structure



By - Mohit Dadheech (MD Sir)

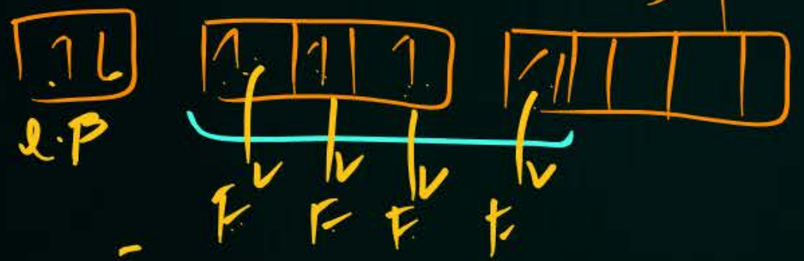
Topics *to be covered*

1. VSEPR Theory (Shape/Geometry of Molecules)

H.W (5)

$3s^2\ 3p^4\ 3d^0$

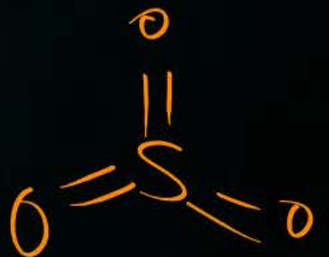
$S_{G.S}$ Covalency = 2 Ex SF_2

$S_{E.S-I}$ 

Covalency = 4 Ex SF_4

$S_{E.S-II}$ Covalency = 6

SF_6 , SO_3



H.W Ans

Cl $3s^2 3p^5$

Ex

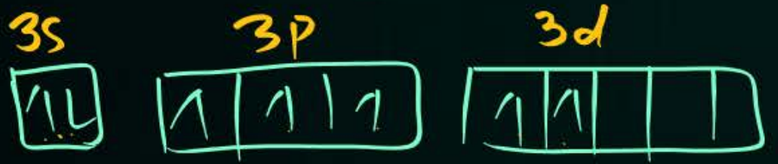
ClF Covalency = 1

$Cl_{G.S}$

$Cl_{E.S-I}$

Covalency = 3 ClF_3

$Cl_{E.S-II}$

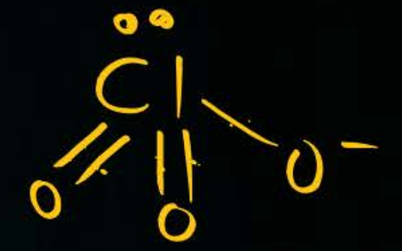


Covalency = 5 ClO_3^-

$Cl_{E.S-III}$

Covalency = 7 ClO_4^-

chlorate ion



Xe $5s^2 5p^6 5d^0$

G.S ↑↓ | ↑↓ | ↑↓ | ↑ | ↑ Covalency = 0

E.S-I ↑↓ | ↑↓ | ↑ | ↑ | ↑ | ↑ Covalency = 2 XeF_2

E.S=II ↑↓ | ↑↓ | ↑ | ↑ | ↑ | ↑ | ↑ Covalency = 4 XeF_4

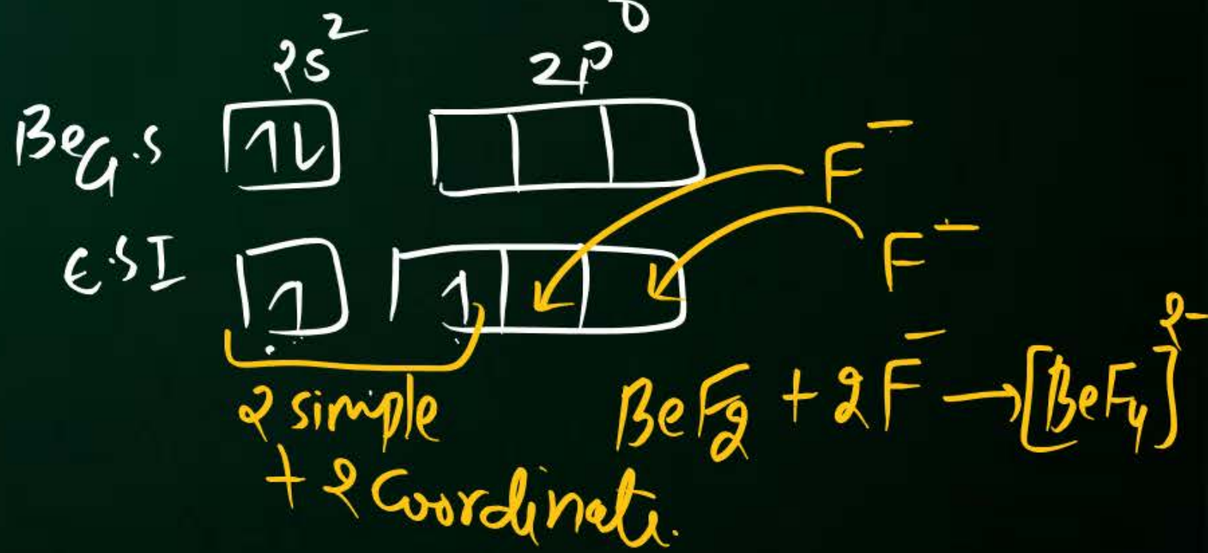
E.S=III ↑↓ | ↑ | ↑ | ↑ | ↑ | ↑ | ↑ | ↑ | ↑ Covalency = 6 XeF_6

XeO_3

QUESTION

Which of the following is not correctly matched ?

1. ClF_3 excited state I of Cl ✓
2. XeO_2F_2 excited state II of Xe ✗
3. BeF_4^{-2} excited state I of Be ✓
4. SF_6 excited state II of S ✓

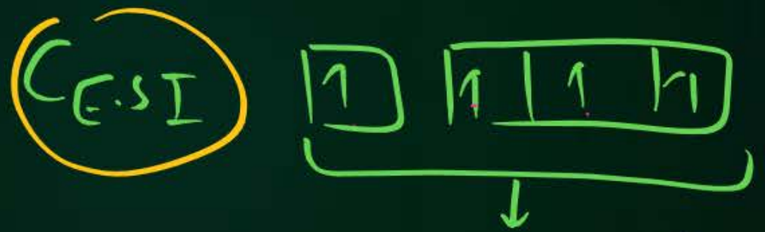


QUESTION

In which of the following molecule electron of 2s in carbon is not promoted to 2p sub shell ?

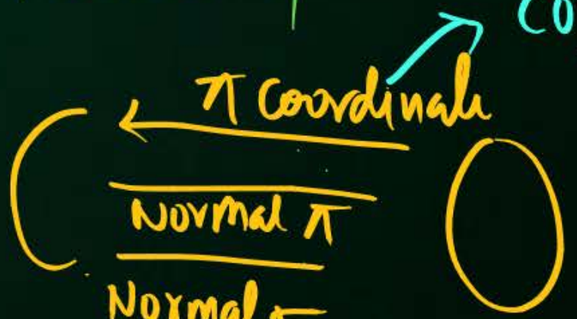
1. HCN

2. CO_2



3. CS_2

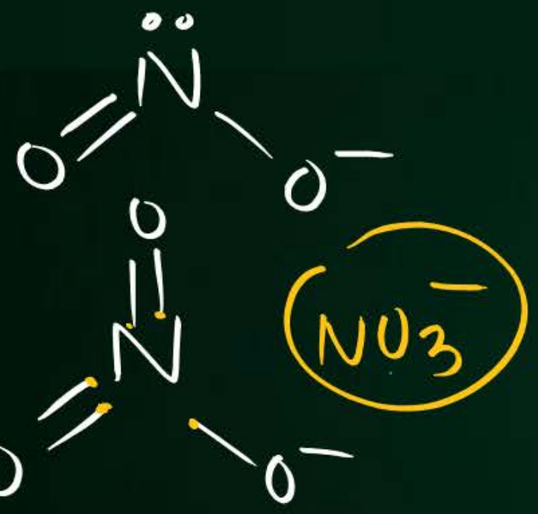
4. CO ✓



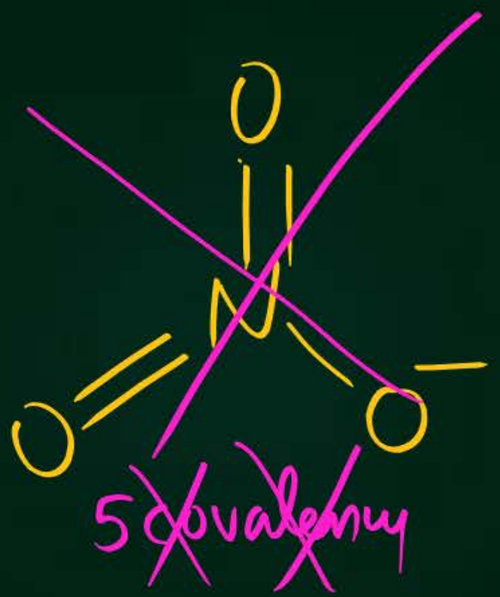
W.O.F Compound of "N" is not possible :-

(1) $\ddot{N}Cl_3$

(2)



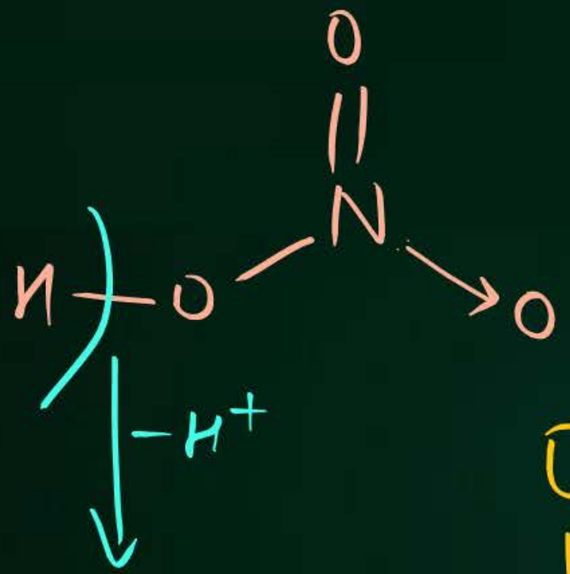
(3)

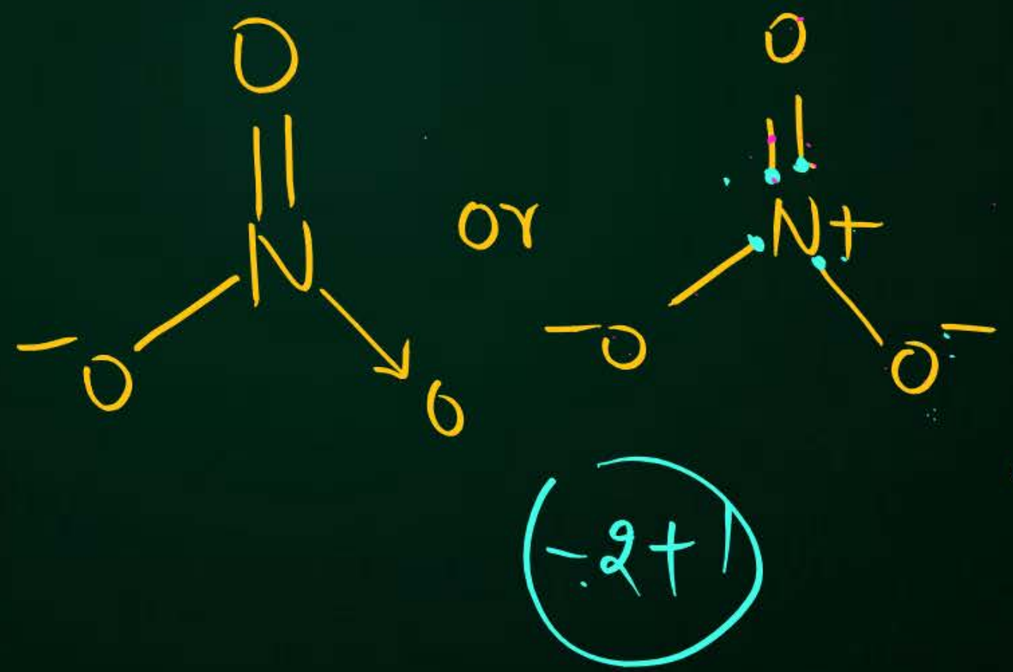


NO_3^-

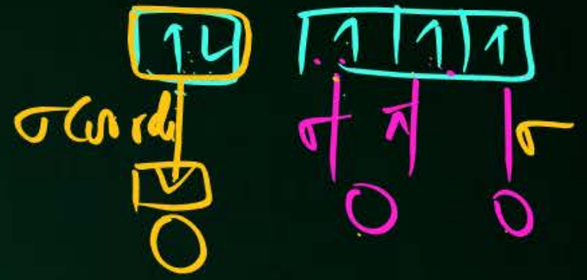
(4) $\ddot{N}H_3$

HNO_3





(N) $2s^2 2p^3$



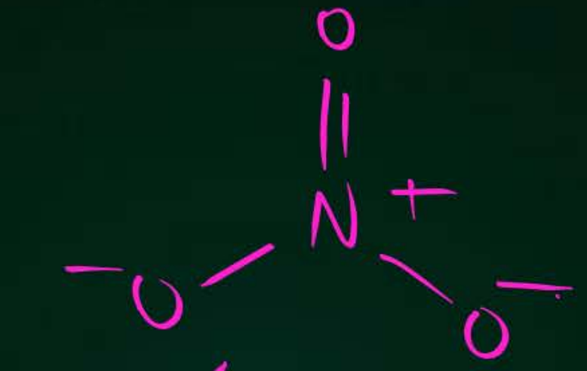
Avg F.C on "O" $= -\frac{2}{3}$

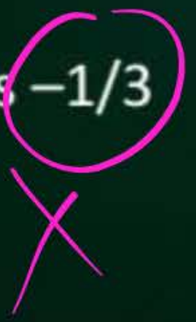
Avg N-O B.O $= \frac{4}{3}$

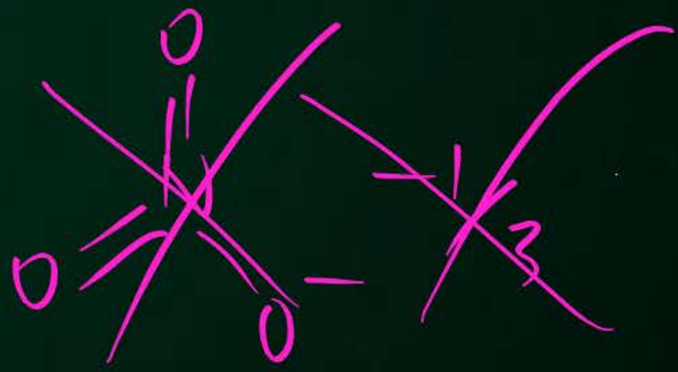
QUESTION

Which is incorrect for NO_3^-

1. Formal charge on N is +1
2. 4 bond pair and 0 lone pair at N
3. Average F.C. on Oxygen atom is –1/3
4. None of these







VSEPR (Valence Shell Electron Pair Repulsion Theory) :

(B.P & L.P)

- It is based on the repulsive interactions of the electron pairs in the valence shell of the atoms.

- According to VSEPR every molecule has a tendency to acquire certain geometrical shape in which repulsion between various e^- pairs is minimized & thus maximize distance between them.

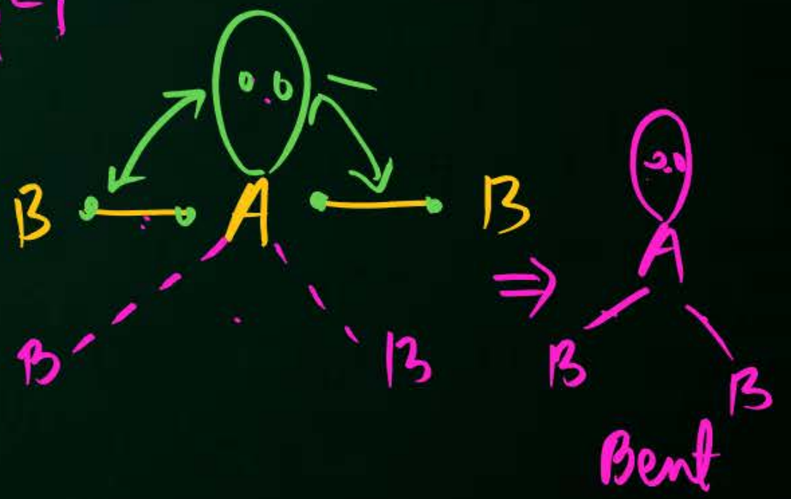
AB_2L_0

B — A — B

$\theta = 180°$

linear.

AB_2L_1



VSEPR (Valence Shell Electron Pair Repulsion Theory) :

Order of Repulsion b/w various e^- pairs :-

$$l.p - l.p > l.p - b.p > b.p - b.p$$

(Note) l.p aquire more avg space on central atom.

NOTE

Overall geometry/shape of Molecule is depend on number of σ Bond pairs & lone pairs

linear

Type of Monocentric Molecules (AB_nL_m)

In Which l.p is "Not present"

- AB_2L_0 → linear ✓
- AB_3L_0 → Triangular planar ✓
- AB_4L_0 → Tetrahedral
- AB_5L_0 → Triangular bipyramidal (TBP)
- AB_6L_0 → Square Bipyramidal/octahedral (SBP)
- AB_7L_0 → Pentagonal Bipyramidal (PBP)

In which l.p is present.

- AB_2L_1 → Bent/Angular/V-shape
- AB_3L_1 → Triangular Pyramidal
- AB_2L_2 → Bent/Angular/V-shape
- AB_4L_1 → See-saw
- AB_3L_2 → Bent-T shape
- AB_2L_3 → linear
- AB_5L_1 → Square pyramidal
- AB_4L_2 → square planar
- AB_6L_1 → distorted octahedral
- AB_5L_2 → Pentagonal Planar

Trick to find n & m in AB_nL_m :

AB_nL_m

A = Central atom

B = σ bond pair = no. of surrounding atoms

L = Lone pair

n = Number of σ bond pair

m = Number of lone pair

$$= \frac{\text{Total Valence } e^-}{8}$$

Quotient = n

Remainder / 2 = m

(Note) If there is −ve or +ve charge present in species then add or subtract e^- accordingly in Valence e^-

❖ Do not apply this trick for odd electron species & species having hydrogen as surrounding atom.

1. CO_2 $\frac{4+6+6}{8} = \frac{16}{8} = Q=2$ $R=0$ AB_2L_0 linear sp

2. SO_3 $\frac{6+6+6+6}{8} = \frac{24}{8} = Q=3$ $R=0$ AB_3L_0 T. planar. sp^2

3. SO_2 $\frac{6+6+6}{8} = \frac{18}{8}$ $Q=2$ $R/2 = 2/2 = 1$ AB_2L_1 Bent sp^2

8) 18 (2 ⇒ Q
16
2 ⇒ R
$R/2 = 2/2 = 1$

(4.) PCl_3

$$\frac{5+7+7+7}{8} = \frac{26}{8}$$

$Q = (3)$

$R = 2$ $\quad \frac{R}{2} = (1)$

AB_3L_1 T. Pyramidal

sp^3

(5) SO_4^{2-}

$$\frac{6+6+6+6+6+2}{8} = \frac{32}{8}$$

$Q = 4$

$R = 0$

AB_4L_0 Tetrahedral

sp^3

(6) NO_2^+

$$\frac{5+6+6-1}{8} = \frac{16}{8} \quad \begin{matrix} \Phi = 2 \\ R = 0 \end{matrix} \quad AB_2L_0 \text{ linear}$$

sp

MDJ

When surrounding atoms are Hydrogen.

no. of σ Bonds = no. of Hydrogen atoms

$$\text{no. of lone pair} = \frac{\text{Valence}^- \text{ of C.A}}{2} - \text{no. of Hydrogens}$$

CH_4

Val e$^-$ = 4

$= \frac{4-4}{2} = 0$

AB_4L_0

sp^3 Tetrahedral.

NH_2^-

$\frac{(5+1)-2}{2} \quad \frac{4}{2} = 2$

no. of l.p.

AB_2L_2

Bent sp^3

(3) NH_3 $\frac{5-3}{2} = \frac{2}{2} = 1$ (l.p)

AB_3L_1 T. Pyramidal sp^3

(4) NH_4^+ $(5-1)$

$\frac{4-4}{2} = 0$

AB_4L_0 Tetrahedral

sp^3

⇒ XeO_2F_2 $\quad \frac{8+6+6+7+7}{8} = \frac{34}{8}$ $\quad Q = 4$

$R = 2$ $\quad \frac{R}{2} = 1$

AB_4L_1 See saw

sp^3d

How to find Hybridisation :

Super duper MDJ

Number of H. O. (L.P. + σ) (AB_nL_m) $(m+n)$		Type of Hybridisation
2	→	sp $s+p$
3	→	sp^2 $s+p+p$
4	→	sp^3 $s+p+p+p$
5	→	sp^3d $s+p+p+p+d$
6	→	sp^3d^2 $s+p+p+p+d+d$
7	→	sp^3d^3 $s+p+p+p+d+d+d$

QUESTION

& Type of Hybridization

Give the correct name of shape of following compounds –

1.	PCl_5 AB_5L_0 sp^3d	11.	$AlCl_3$	21.	BrF_5
2.	SF_6	12.	$BeCl_2$	22.	BrF_3
3.	SO_2	13.	SF_4	23.	I_3^-
4.	SO_3	14.	SF_2	24.	ICl_2^-
* 5.	NH_4^+	15.	XeO_4	25.	I_3^+
* 6.	H_2O	16.	XeO_3	26.	ICl_2^+
* 7.	H_3O^+	17.	XeF_6	27.	PCl_4^+
8.	BF_3	18.	XeF_4	*28.	BH_4^-
9.	BF_4^-	19.	XeF_2	29.	NO_3^-
10.	PCl_6^-	20.	ClF_3		

QUESTION

Which of the following molecules has trigonal planar geometry :

1. NH_3
2. BF_3
3. PCl_3
4. IF_3

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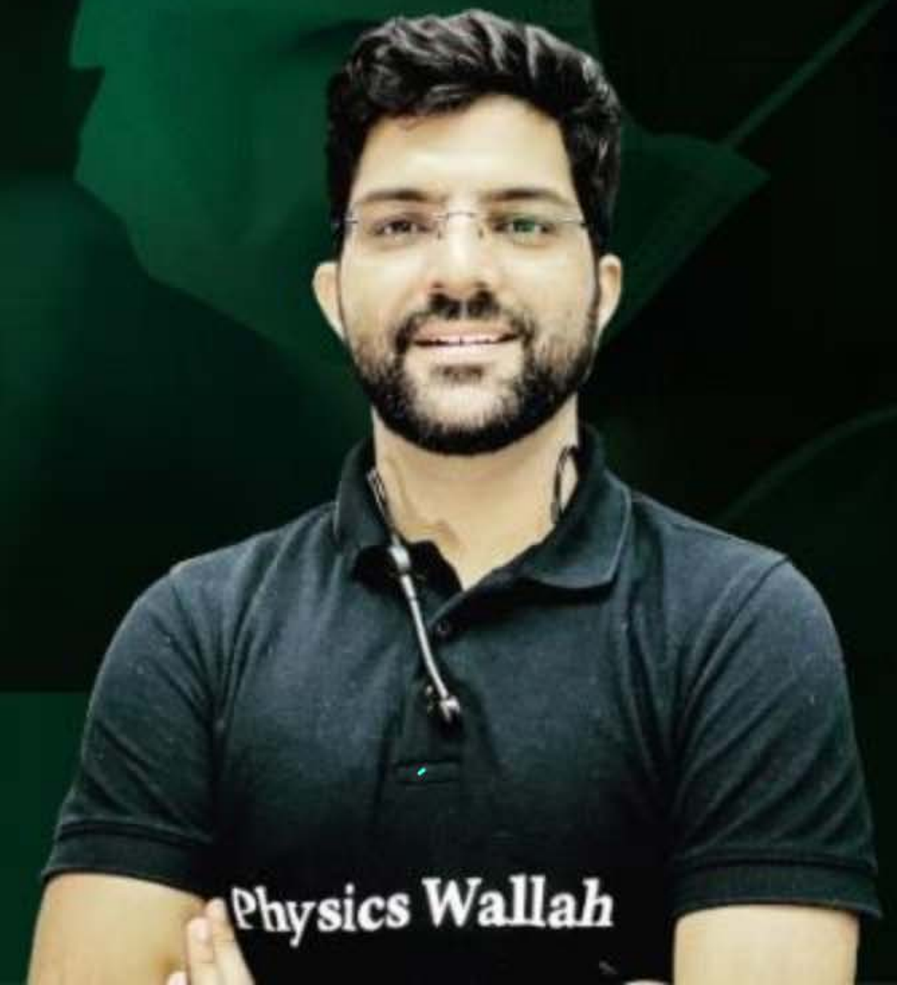
FOR NEET 2025

Lecture - 05 | Inorganic Chemistry

Chemical Bonding & Molecular Structure



By - Mohit Dadheech (MD Sir)

Topics *to be covered*

1. VSEPR Theory (Shape/Geometry of Molecules) (Part-II)

QUESTION

Home work Ans.

Give the correct name of shape of following compounds –

1. PCl_5 AB_5L_0 sp^3d
2. SF_6 AB_6L_0 sp^3d^2
3. SO_2 AB_2L_1 sp^2
4. SO_3 AB_3L_0 sp^2
5. NH_4^+ AB_4L_0 sp^3
6. H_2O AB_2L_2 sp^3
7. H_3O^+ AB_3L_1 sp^3
8. BF_3 AB_3L_0 sp^2
9. BF_4^- AB_4L_0 sp^3
10. PCl_6^- AB_6L_0 sp^3d^2
11. $AlCl_3$ AB_3L_0 sp^2
12. $BeCl_2$ AB_2L_0 sp
13. SF_4 AB_4L_1 sp^3d
14. SF_2 AB_2L_2 sp^3
15. XeO_4 AB_4L_0 sp^3
16. XeO_3 AB_3L_1 sp^3
17. XeF_6 AB_6L_1 sp^3d^3
18. XeF_4 AB_4L_2 sp^3d^2
19. XeF_2 AB_2L_3 sp^3d
20. ClF_3 AB_3L_2 sp^3d
21. BrF_5 AB_5L_1 sp^3d^2
22. BrF_3 AB_3L_2 sp^3d
23. I_3^- AB_2L_3 sp^3d
24. ICl_2^- AB_2L_3 sp^3d
25. I_3^+ AB_2L_2 sp^3
26. ICl_2^+ AB_2L_2 sp^3
27. PCl_4^+ AB_4L_0 sp^3
28. BH_4^- AB_4L_0 sp^3
29. NO_3^- AB_3L_0 sp^2

H_2O AB_2L_2 Bent sp^3

$6-2=4$ $\frac{4}{2}=2$ L.P

H_3O^+ $(6-1)=5$ $\frac{5-3}{2}=1$

AB_3L_1 sp^3 T. Pyramidal.

I_3^- $\frac{7+7+7+1}{8}$ $\frac{22}{8}$ $Q=2$ AB_2L_3 linear

$R=6$

$R/2=3$

MD 'J

Jab Surrounding Mai Halogen No to Hydrogen wala. Jugaad lagen do.

XeF_4

$\frac{8-4}{2} = 2$ l.p

AB_4L_2

BrF_5 $\quad \frac{7-5}{2} = 1$

AB_5L_1

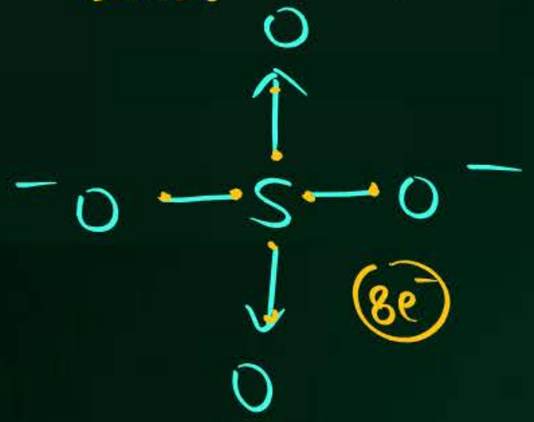
PCl_4^+ $\quad AB_4L_0$

sp3

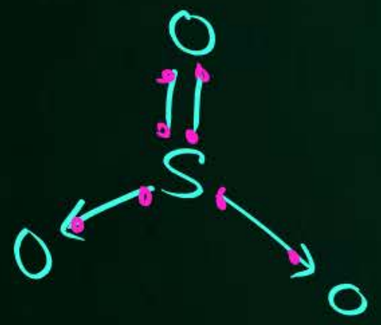
Old structure

Based on Octet Rule.

SO_4^{2-}



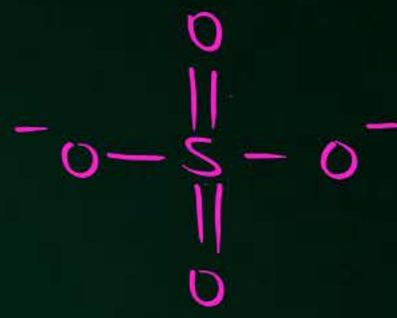
SO_3



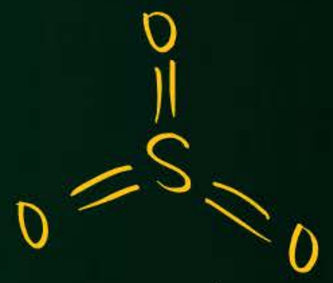
SO_2

New Structure

Based on Modern Concept



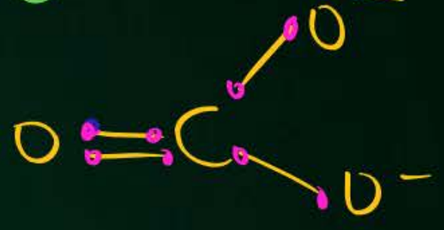
Hypervalent.



W.O.F Molecule does not have dative Bond (coordinate)

(1) CO

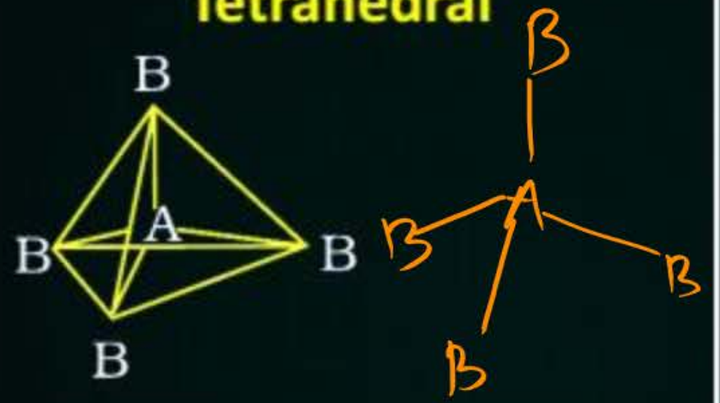
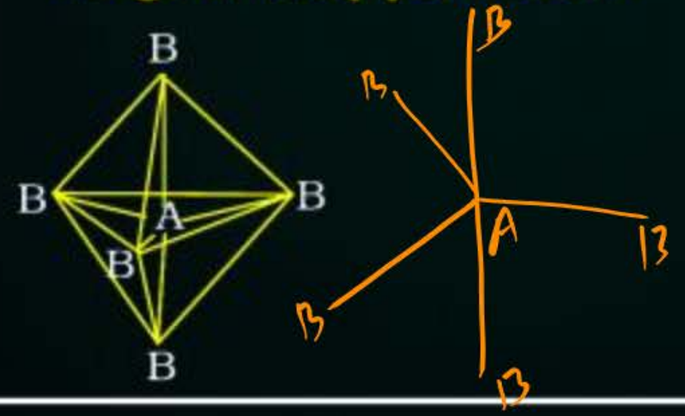
(2) CO_3^{2-}



(3) SO_4^{2-} old structure

(4) All of these

Molecule Type	Shape/Molecular Geometry	Remarks
AB_2L_0	**Linear** **B – A – B**	$\theta = 180°$ ✓ Planar structure Imp. Ex. : $BeCl_2$, CO_2, NO_2^+ $HgCl_2$
AB_3L_0	**Trigonal Planar** 	$\theta = 120°$(Three) ✓ Planar structure Imp. Ex. : BF_3, BCl_3, SO_3 etc.

Molecule Type	Shape/Molecular Geometry	Remarks
AB_4L_0	**Tetrahedral** 	θ = 109.5° or 109° 28′ (Six) Non-planar structure Imp. Ex. : CH_4, BF_4^-, NH_4^+ etc.
AB_5L_0	**Trigonal Bipyramidal** 	Non-planar structure ✓ Different angles are present ✓ Axial angle θ = 90° (Six) Equatorial angle θ = 120°(Three) Axial θ < Equ. θ All bond lengths are not same → axial B·L > eq B·L Imp. Ex. : PCl_5 * S·A must be same

Q In CH_4 Molecule How many H-C-H Angles are present

(1) 4

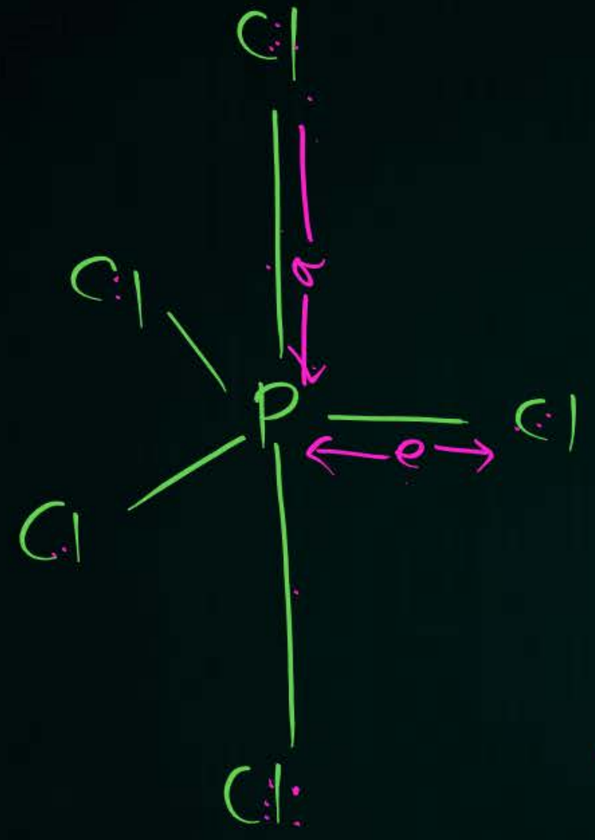
(2) 2

(3) 6

(4) 3

CH_4 AB_4L_0

Tetra



$a \Rightarrow$ axial B.L

$e \Rightarrow$ eq. B.L

$a > e$

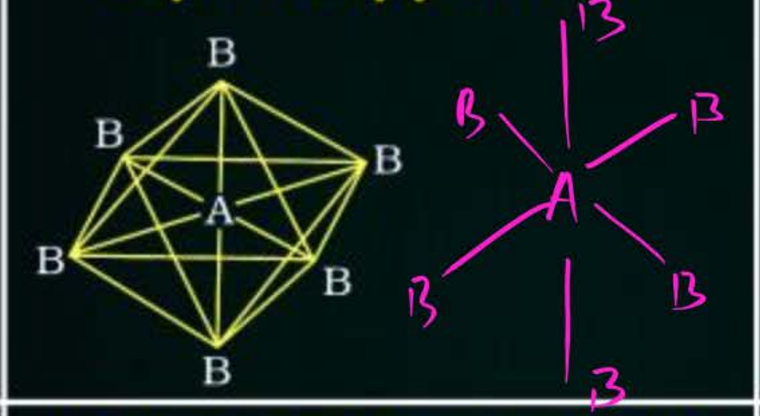
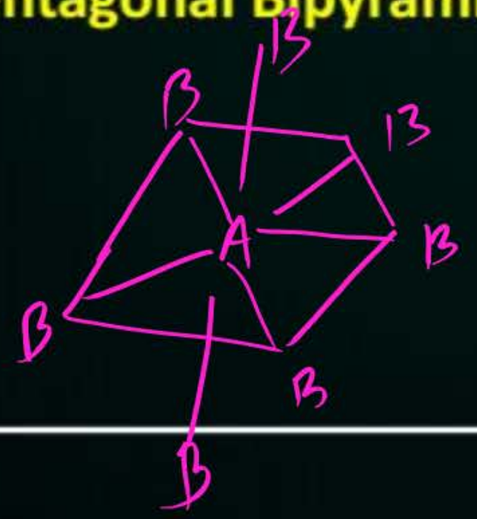
$\therefore a < e$

Bond length.

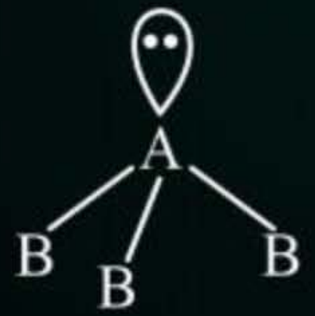
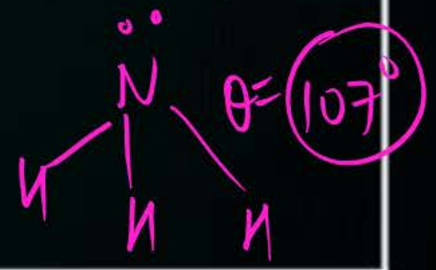
Bond angle

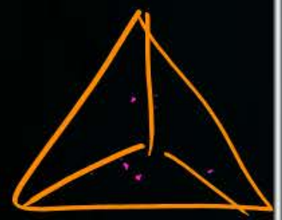
$$PCl_5 \xrightarrow{\Delta} PCl_3 + Cl_2$$

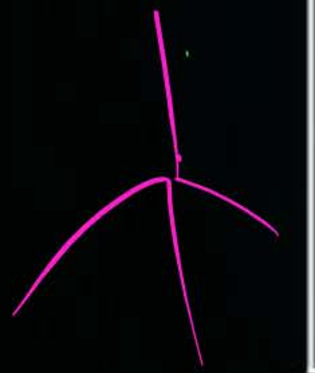
axial P–Cl B.L $>$ eq. P–Cl B.L

Molecule Type	Shape/Molecular Geometry	Remarks
AB_6L_0	**Square Bipyramidal** 	Non-planar structure ✓ Also known as octahedral ✓ Axial θ = Equ. θ ✓ Axial θ = 90° (Eight) ✓ Equa. θ = 90° (Four) ✓ } Total (12) Imp. Ex : SF_6, PCl_6^- etc. θ = 180° (Thike)
AB_7L_0	**Pentagonal Bipyramidal** 	Non-planar structure ✓ Axial θ > Equ. θ Axial θ = 90° (Ten) ✓ Equa. θ = 72° (Five) ✓ Imp. Ex : IF_7

(without l.p)

Molecule Type	Shape/Molecular Geometry	Remarks
AB_2L_1	**Bent / V shape** / Angular	$\theta < 120°$ Planar structure Imp. Ex. : SO_2, NO_2^-, O_3 etc.
AB_3L_1	**Trigonal Pyramidal** 	$\theta < 109.5°$ ✓ Non-planar structure ✓ Imp. Ex. : NH_3 





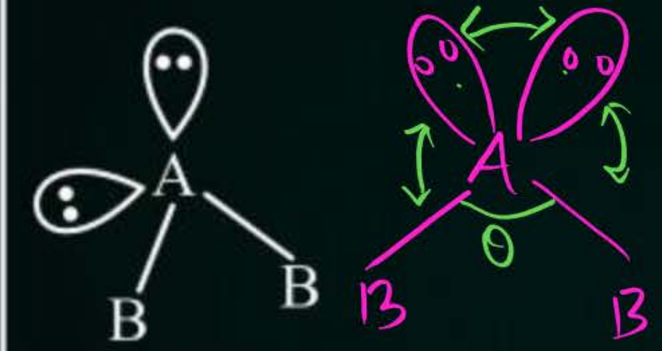
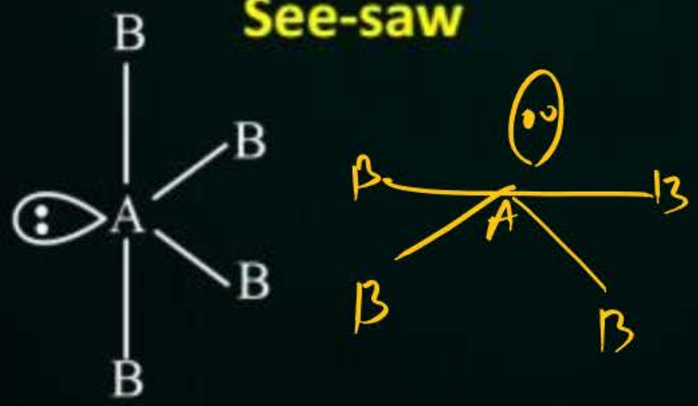
O_3

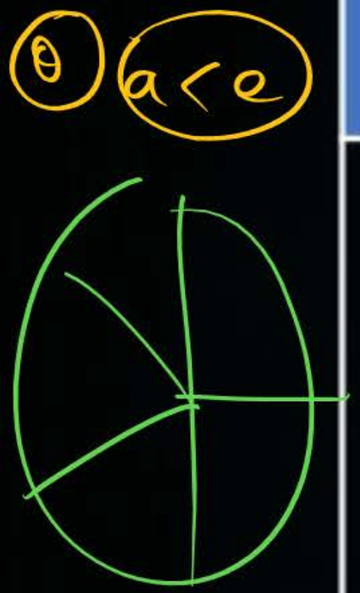
$\frac{18}{8}$ $Q = 2$

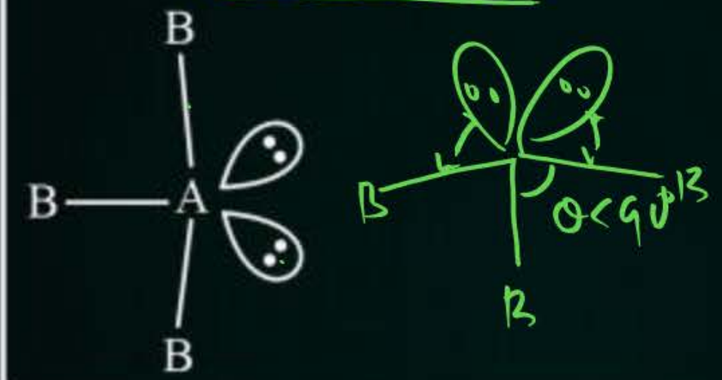
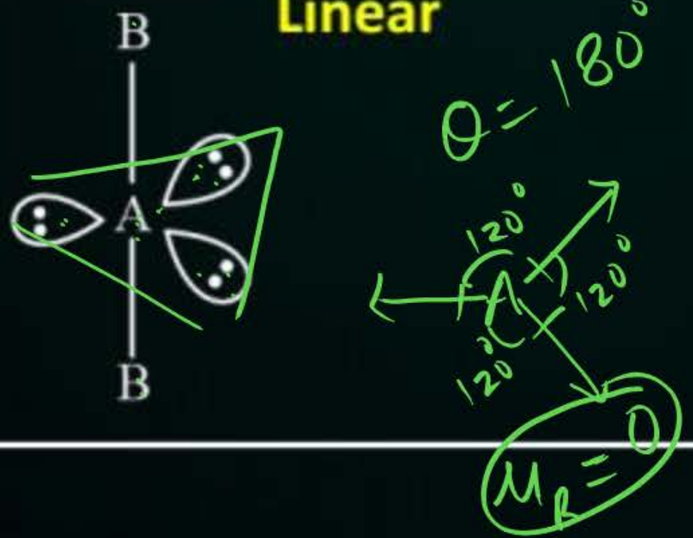
$R = 2$

$\frac{R}{2} = 1$

AB_2L_1

Molecule Type	Shape/Molecular Geometry	Remarks
AB_2L_2	**Bent / V shape** 	$\theta < 109.5°$ Planar structure Isostructural with AB_2L_1 Imp. Ex. : H_2O, SF_2 etc. $\theta = 104.5°$
AB_4L_1	**See-saw** 	Non-planar structure Imp. Ex. : SF_4 l.p occupy equatorial position.



Molecule Type	Shape/Molecular Geometry	Remarks
AB_3L_2	**Bent T shape** 	Planar structure ✓ Imp. Ex. : ClF_3, BrF_3
AB_2L_3	**Linear** 	Planar structure Isostructural with AB_2L_0 ✓ Imp. Ex. : XeF_2, I_3^- etc.

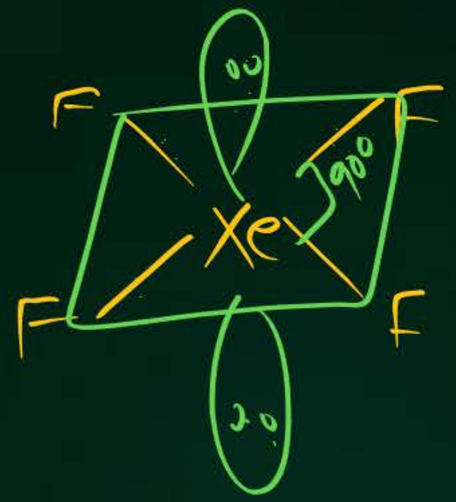
a=e

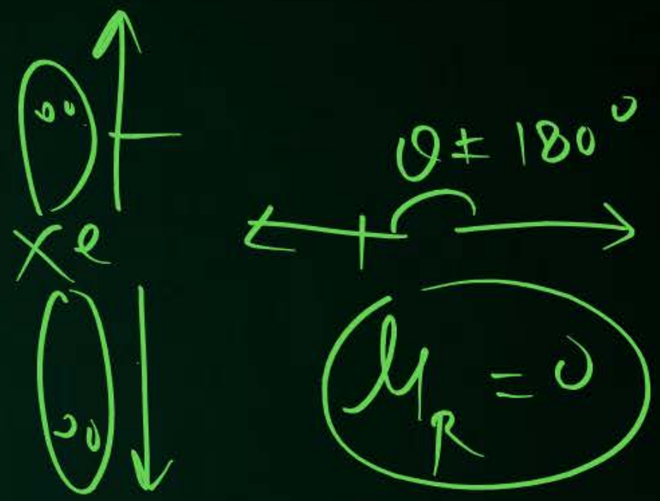
θ

Molecule Type	Shape/Molecular Geometry	Remarks
AB_5L_1	**Square Pyramidal**	Non-planar structure Imp. Ex. : BrF_5 l·p at any position ∵ a=e
AB_4L_2	**Square Planar**	Planar structure θ = 90° (Four) Imp. Ex. : XeF_4, ICl_4^- etc. Both l·p must be opposite to each other.

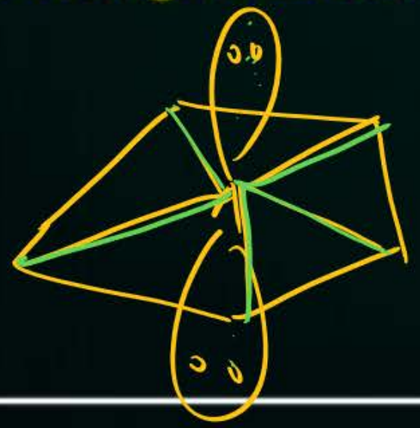
to avoid l·p-l·p repulsion at 90°.

XeF_4 AB_4L_2 Sq Planar





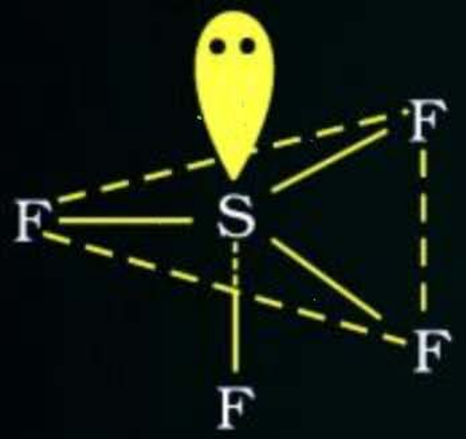
Not in NCERT

Molecule Type	Shape/Molecular Geometry	Remarks
AB_6L_1	**Distorted Octahedral**	Non-planar structure $\theta \neq 90°$ Imp. Ex. : XeF_6 also known as Capped octahedral.
AB_5L_2	**Pentagonal Planar** 	[redacted]-planar structure $\theta = 72°$ (Five) Imp. Ex. : $[XeF_5]^-$

Lone pair position in AB_4L_1 see-saw molecule

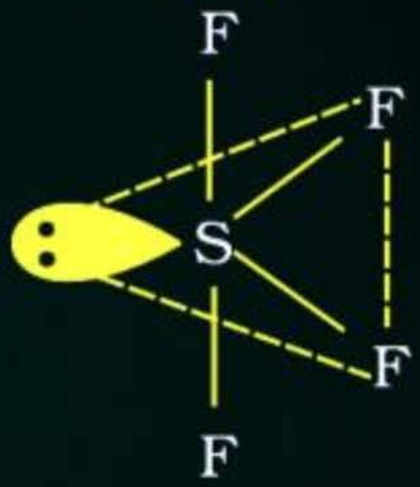
Ex. SF_4

(A)



3 l·p-b·p repulsions at 90°

(B)



See-Saw

2 l·p-b·p repulsions at 90°

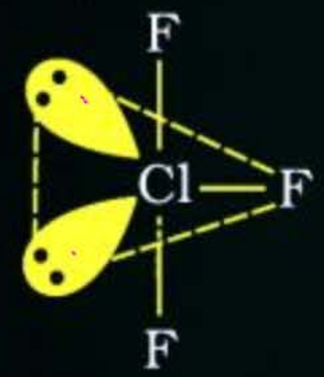
More stable

B is more stable

Lone pair position in AB_3L_2 Bent T molecule

Ex. ClF_3

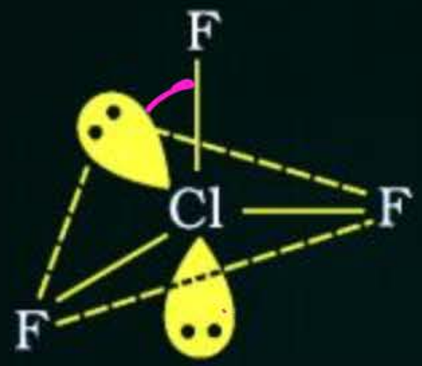
(A)



4 l.p - b.p repulsions (less in number)

More stable

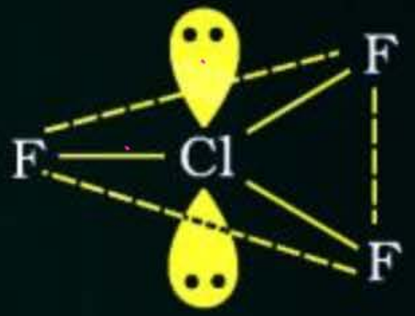
(B)



1 l.p - l.p repulsion at 90°

3 l.p - B.P repulsion at 90°

(C)



6 l.p - b.p repulsions at 90°

AB_5L_0

(l.p occupies equatorial positions in T.B.P parent geometry.

AB_4L_1

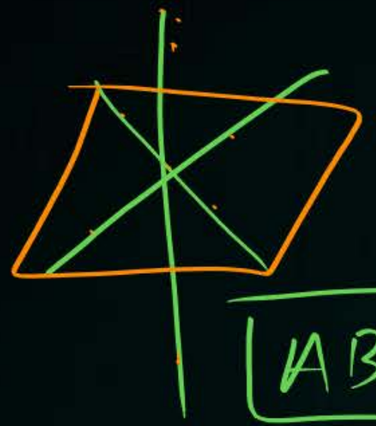
See Saw

AB_3L_2

Bent-T

AB_2L_3

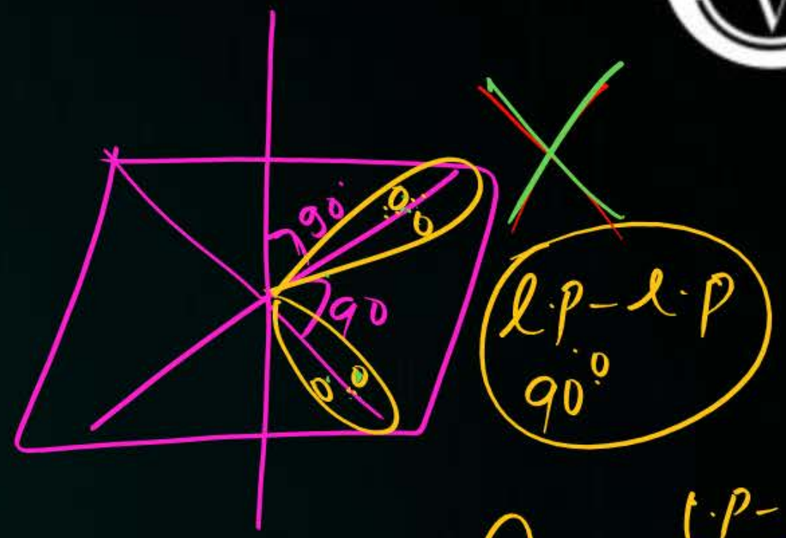
linear



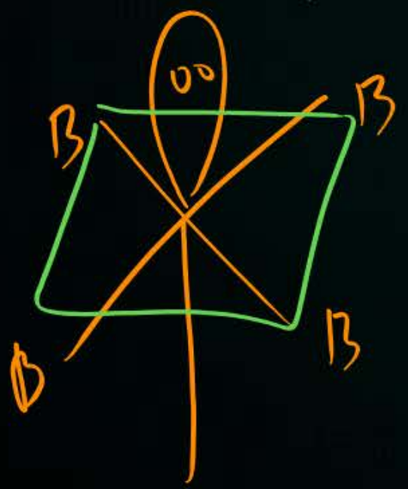
$a = e$

90°

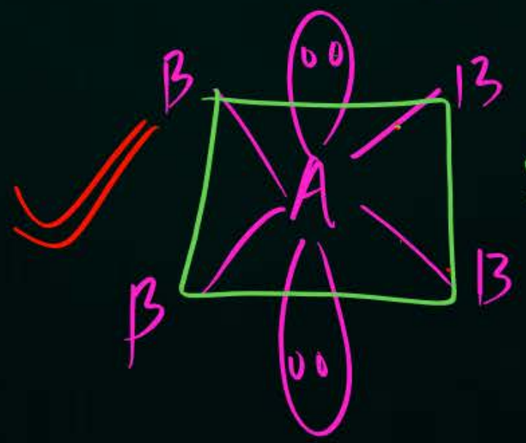
AB_6L_0



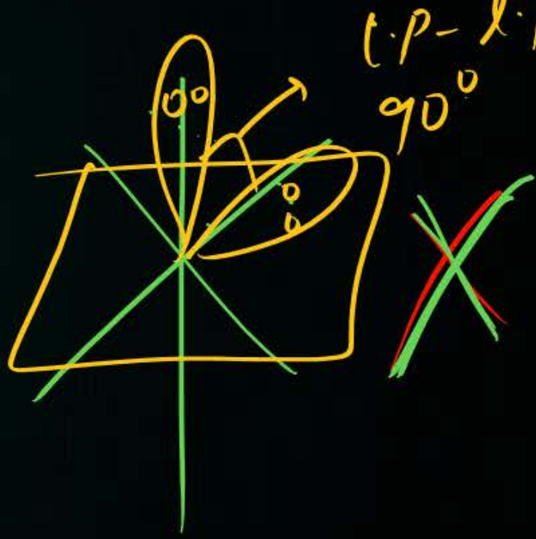
AB_5L_1 Sq. Pyramidal



AB_4L_2



Sq. planar.



QUESTION

Which of the following is planar species :

1. CH_4 AB_4L_0 ✗
2. SF_4 AB_4L_1 Non planar ✗
3. BCl_3 AB_3L_0 Planar ✓
4. All of these

QUESTION

Which of the following molecules has trigonal planar geometry :

1. NH_3
2. BF_3
3. PCl_3
4. IF_3

H.W

QUESTION

Among the following molecules

(i) XeO_3 AB_3L_1 (ii) $XeOF_4$ AB_5L_1 (iii) XeF_6 AB_6L_1

Those having same number of lone pairs on Xe are :

1. (i) and (ii) only
2. (i) and (iii) only
3. (ii) and (iii) only
4. (i), (ii) and (iii)

QUESTION

In the protonation of H_2O, charge occurs in :

1. Hybridisation state of oxygen

H.W

2. Shape of molecule

3. Covalency of oxygen

4. (2) & (3) Both

Homework

From Module - 1

Questions Based on
Shape & Hybridisations

THANK YOU

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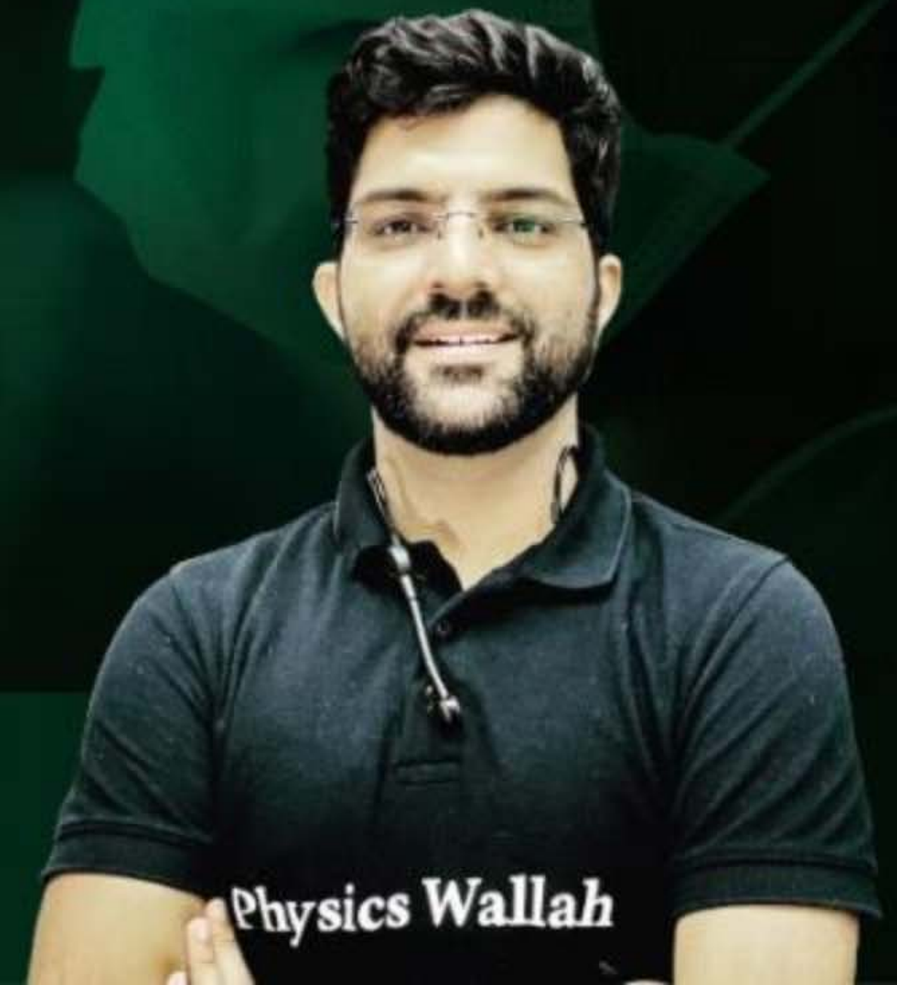
FOR NEET 2025

Lecture - 06 | Inorganic Chemistry

Chemical Bonding & Molecular Structure

By - Mohit Dadheech (MD Sir)



Topics *to be covered*

1. Valence Bond Theory Part - I : Hybridisation

$H_2\underline{O} + H^+ \longrightarrow H_3\underline{O}^+$

AB_2L_2

sp^3

Bent

Covalency = 2

104.5°

AB_3L_1

sp^3

T. pyramidal

Covalency = 3

0 Use

l.p lagao
B.A Ghatao

$BF_3 + F^- \longrightarrow BF_4^-$

True / False

(1) Hybridisation change (T)

(2) Bond angle ↑se (F)

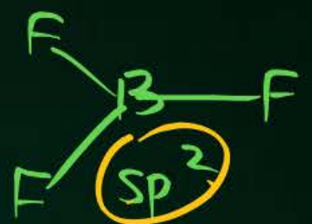
(3) Covalency ↓se (F)

(4) % s character in Hybrid orbital ↓se (T)

(5) planarity change (T)

(6) shape remain same (F)

BF_3

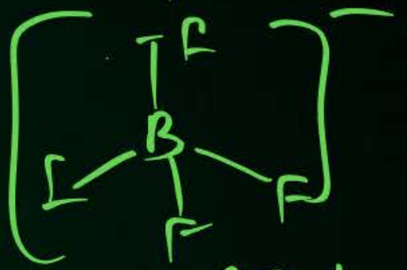


AB_3L_0

T. planar

Cov → 3 $\theta = 120^\circ$

BF_4^-



AB_4L_0

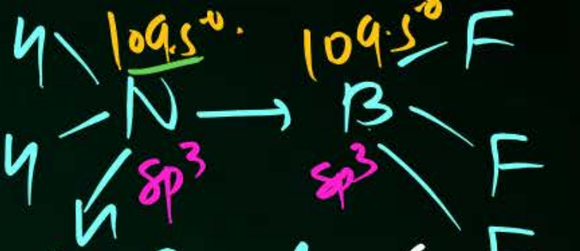
sp^3

tetra (Non plana

Cov = 4

$\theta = 109.5^\circ$

	sp^2	sp^3
%	33.33	25%



① Lewis Base - Lewis Acid Reaction (Neutralisation)

② Covalency arround B & N ↑se

③ Hybridisation of B Changed. But For N Remains Same.

④ Shape arround Both N & B has been changed (Tetrahedral)

⑤ Bond Angle arround B ↓se
θ arround N ↑se

Formation of CH_4 Without Hybridisation :-

C $2s^2 2p^2$

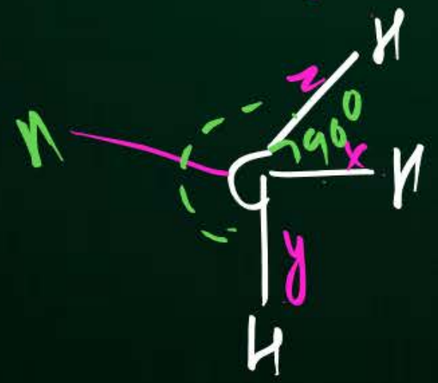
$C_{E.S.I}$: 2s | $2p_x$ $2p_y$ $2p_z$ — each box ↑

1s | 1s | 1s | 1s

H H H H

1 Bond → 2s – 1s (weak)

3 Bond → 2p – 1s (strong)



→ Covalency = 4 (Tetra valent) (T)

→ Non Planar (T)

→ Position of 4th C–H Bond is (T)
Uncertain w.r.t 3 C–H Bonds.

→ All C–H Bonds are equivalent (F)

→ 3 C–H Bonds are stronger than 1 C–H Bond (T)

→ Tetrahedral (F)
θ 109.5°

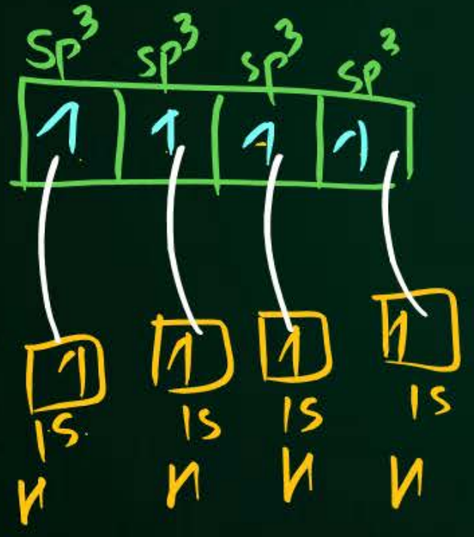
CH_4 with Hybridisation (Real)

C $2s^2\ 2p^2$

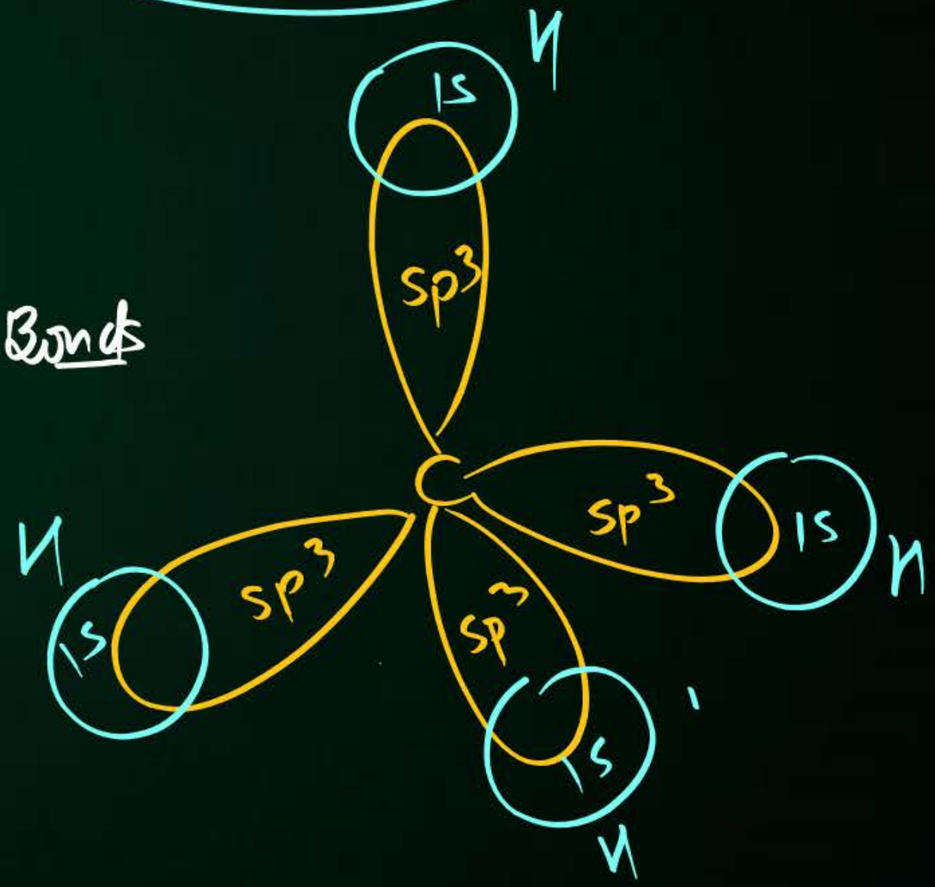
C (E.S.I) — 2s | $2p_x$ | $2p_y$ | $2p_z$

$(s+p+p+p) \Rightarrow (sp^3, sp^3, sp^3, sp^3)$

(Tetravalent)
Covalency = 4
Nonplanar ✓
Tetrahedral ✓
$\theta = 109.5^\circ$ ✓
All Bonds are equivalent ✓



Four $(sp^3 - 1s)$ Bonds



Q In CH_4 Molecule Hybridisation is Needed to Explain

(1) Tetravalency of C

(2) Non planarity.

(3) tetrahedral geometry around C

(4) All of these.

Valence Bond Theory Part - I : Hybridisation

In hybridisation orbitals having same or similar energy combine with each other & form new orbitals of same energy.

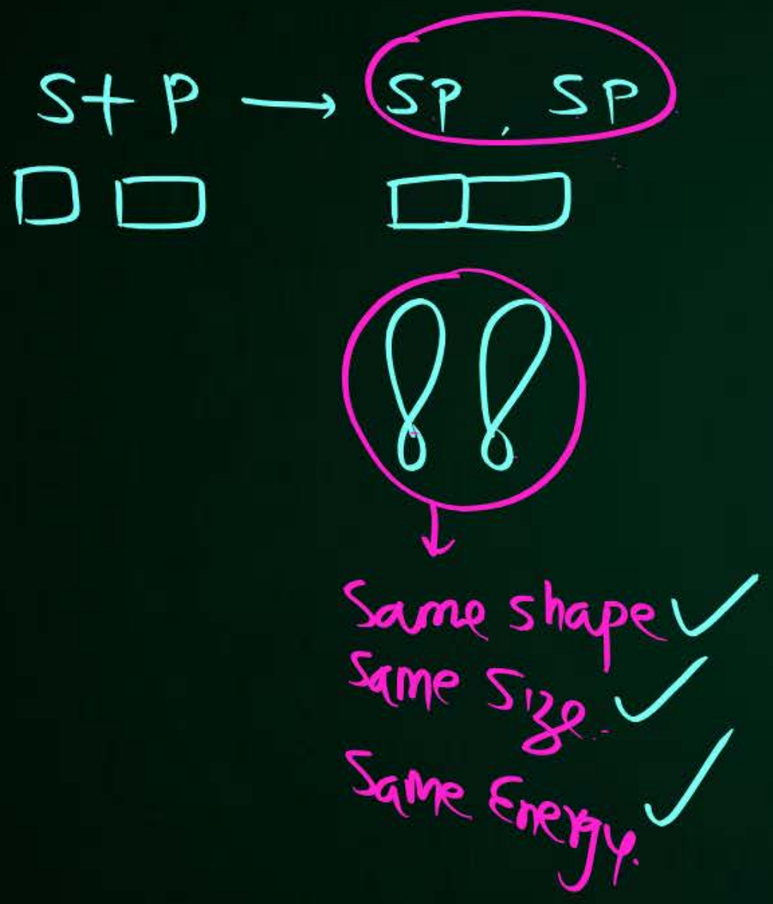
Important Points :

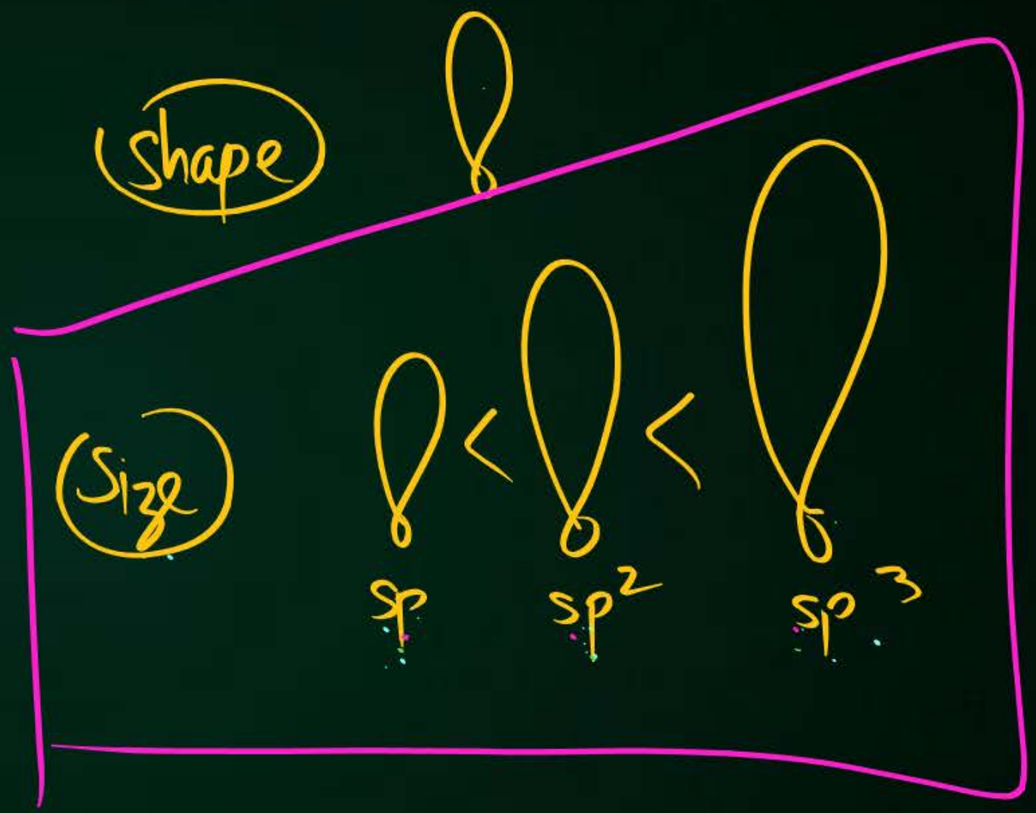
1. The number of hybrid orbitals is equal to the number of the atomic orbitals that get hybridised.

Jitne milenge → Utne Banenge.
(A.O) (H.O)

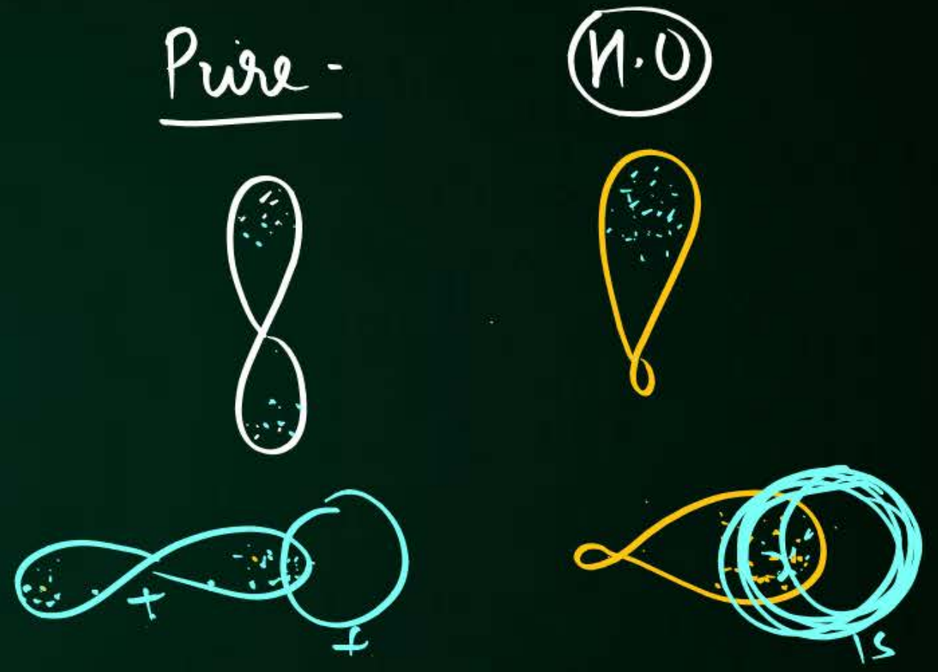
- Hybridisation is reconstruction & reorganization of orbitals. ✓

2. The hybridised orbitals are always equivalent in energy and shape.

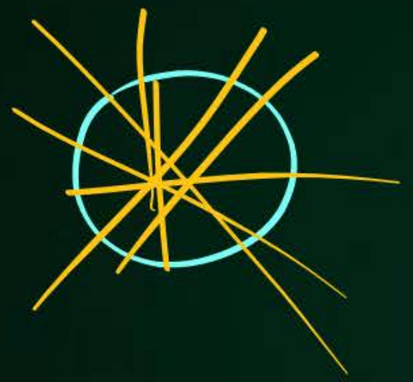




3. The hybrid orbitals are more effective in forming stable bonds than the pure atomic orbitals.



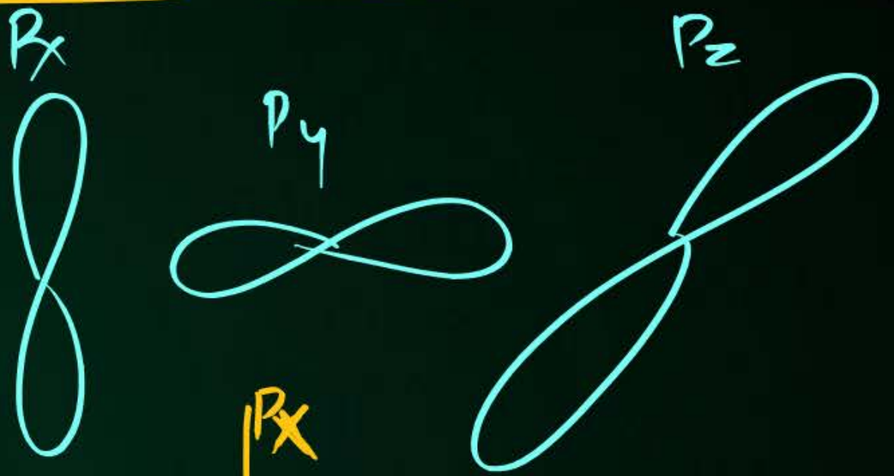
4. During the mixing of s & p orbitals directional nature of s increases while p increases its angular nature.

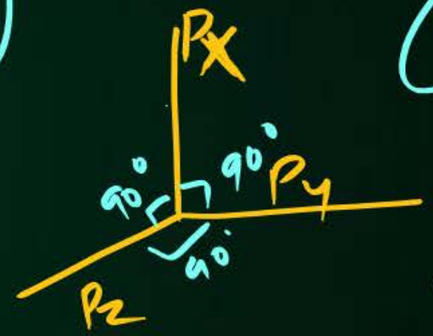


$\theta \Rightarrow$ koi kami nahi

"s" Angle ki dukaan nai

directional ✗





directional ✓

Angle → only 90°

1s + 2p 2s + 2p ✓
3s + 3p + 3d ✓✓

Important conditions for hybridization :

1. The orbitals present in the valence shell of the atom are hybridised. (It is orbitals which hybridize not e^-) ✓
   3d + 4s ✓✓ d-Block
2. Orbitals having paired e^-, single e^- & vacant orbitals all can participate in hybridisation.
3. Excitation or promotion of e^- is not an essential condition prior to hybridization. ✓
4. Only those orbitals need to hybridize which forms σ bond & keep the lone pair.
5. So the no. of hybrid orbital = σ bond + lone pair (n) + (m).

AB_nL_m

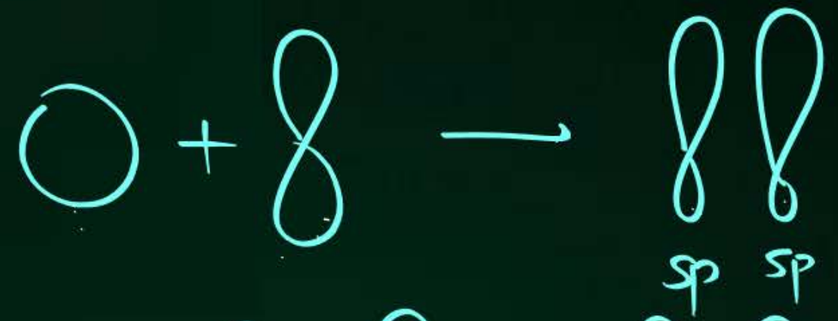
3d { 4s
Low Energy gap.

MDJ → H.O Ke sirf 2 Kaam
① → σ Banayega
② → l.p Rakhega.

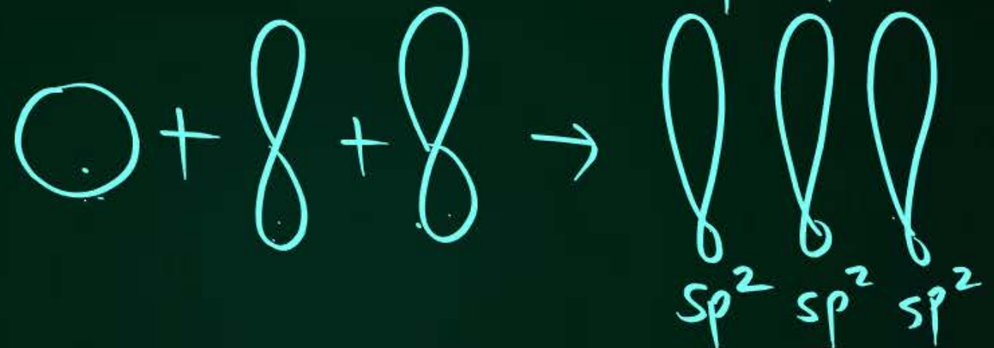
Type of Hybridisation

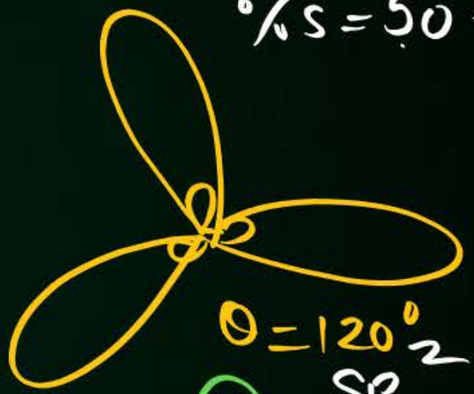
orientation

(i) sp

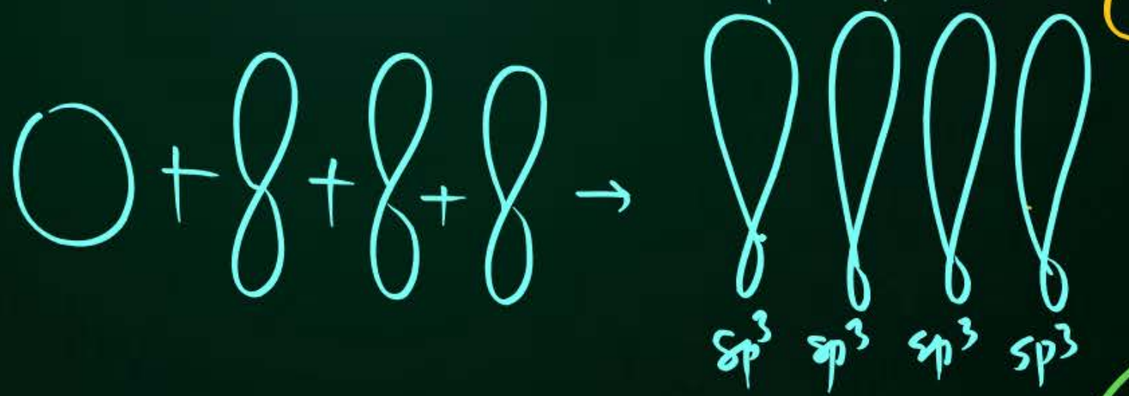


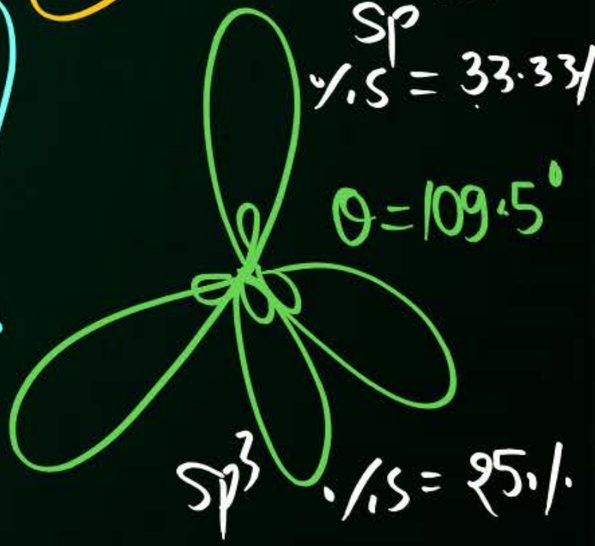
(ii) sp^2





(iii) sp^3





Type of d-orbitals used in hybridization :

sp^3d = d_{z^2}

sp^3d^2 = d_{z^2}, $d_{x^2-y^2}$

sp^3d^3 = d_{z^2}, $d_{x^2-y^2}$, d_{xy}

(d) Vala Hybridisation

↓

group Hybridisation

sp^3d = sp^2 + Pd
(s+p+p)

sp^3d^2 = sp^2d + Pd

sp^3d^3 = sp^2d^2 + Pd

Q Set of orbitals used in Hybridisation of 'S' during the Formation of SF_6 Molecule.

SF_6 AB_6L_0 | sp^3d^2

$S + P_x + P_y + P_z + d_{z^2} + d_{x^2-y^2}$

Q In which of the following species both axial & non axial d orbitals are used in hybridisation

(1) SF_4 AB_4L_1 sp^3d — $(d_{z^2}, d_{x^2-y^2})$ axial.

(2) ICl_4^- AB_4L_2 sp^3d^2.

(3) ✓ XeF_6 AB_6L_1 sp^3d^3 → $d_{z^2}, d_{x^2-y^2}, d_{xy}$ — d_{xy}, d_{yz}, d_{xz} Non axial.

(4) SF_2 ✗ AB_2L_2 sp^3

(H.W)

d-orbitals used.

d orbitals remains Pure

XeF_4

IF_7

ICl_2^-

XeF_2

ClF_3

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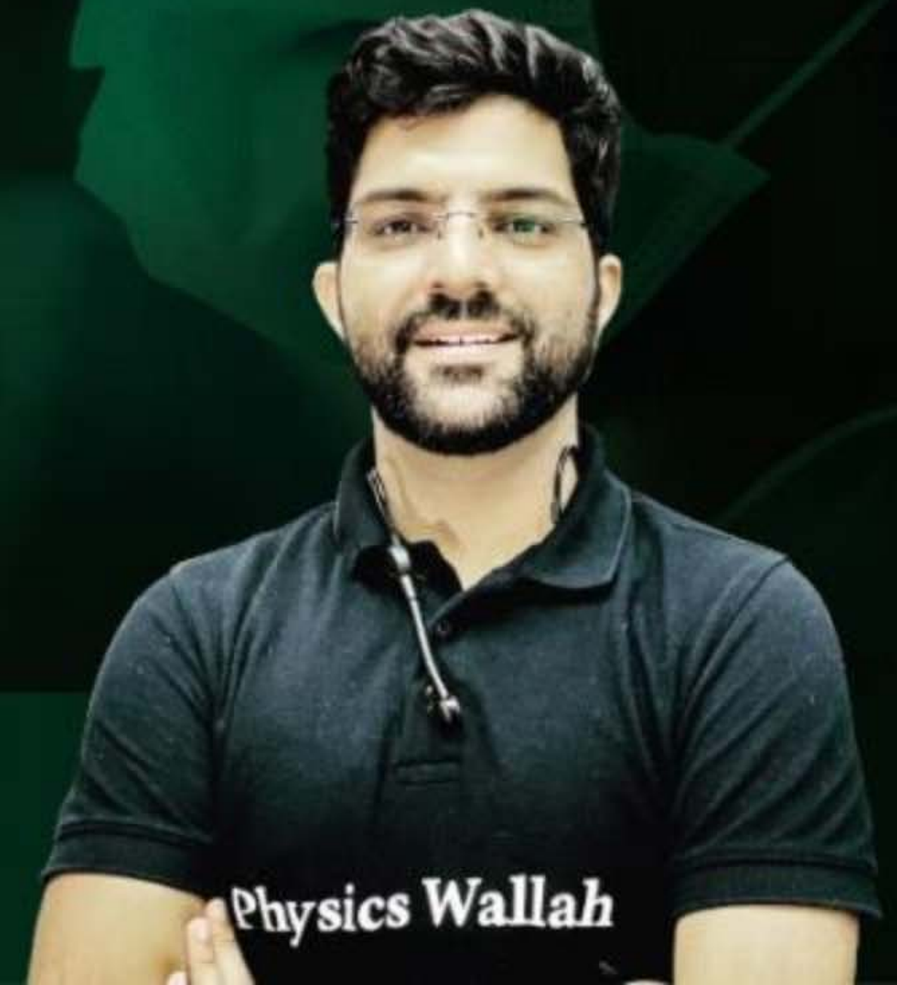
FOR NEET 2025

Lecture - 07 | Inorganic Chemistry

Chemical Bonding & Molecular Structure

By - Mohit Dadheech (MD Sir)



Topics *to be covered*

1. Valence Bond Theory Part - 2 : Overlapping
2. Bond Identity

Overlapping :

According to orbital overlap concept, the formation of a covalent bond between two atoms results by pairing of electrons present in the valence shell having opposite spins.

(Orbital)

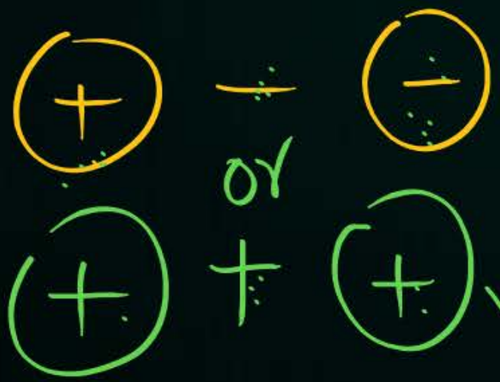
Mechanism of Covalent Bond formation.

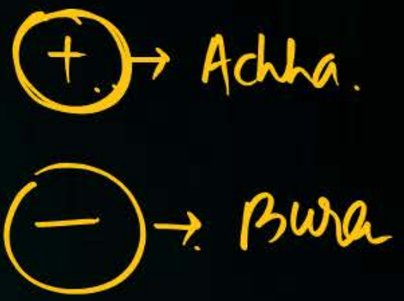
MDJ

⇒ Positive overlapping.

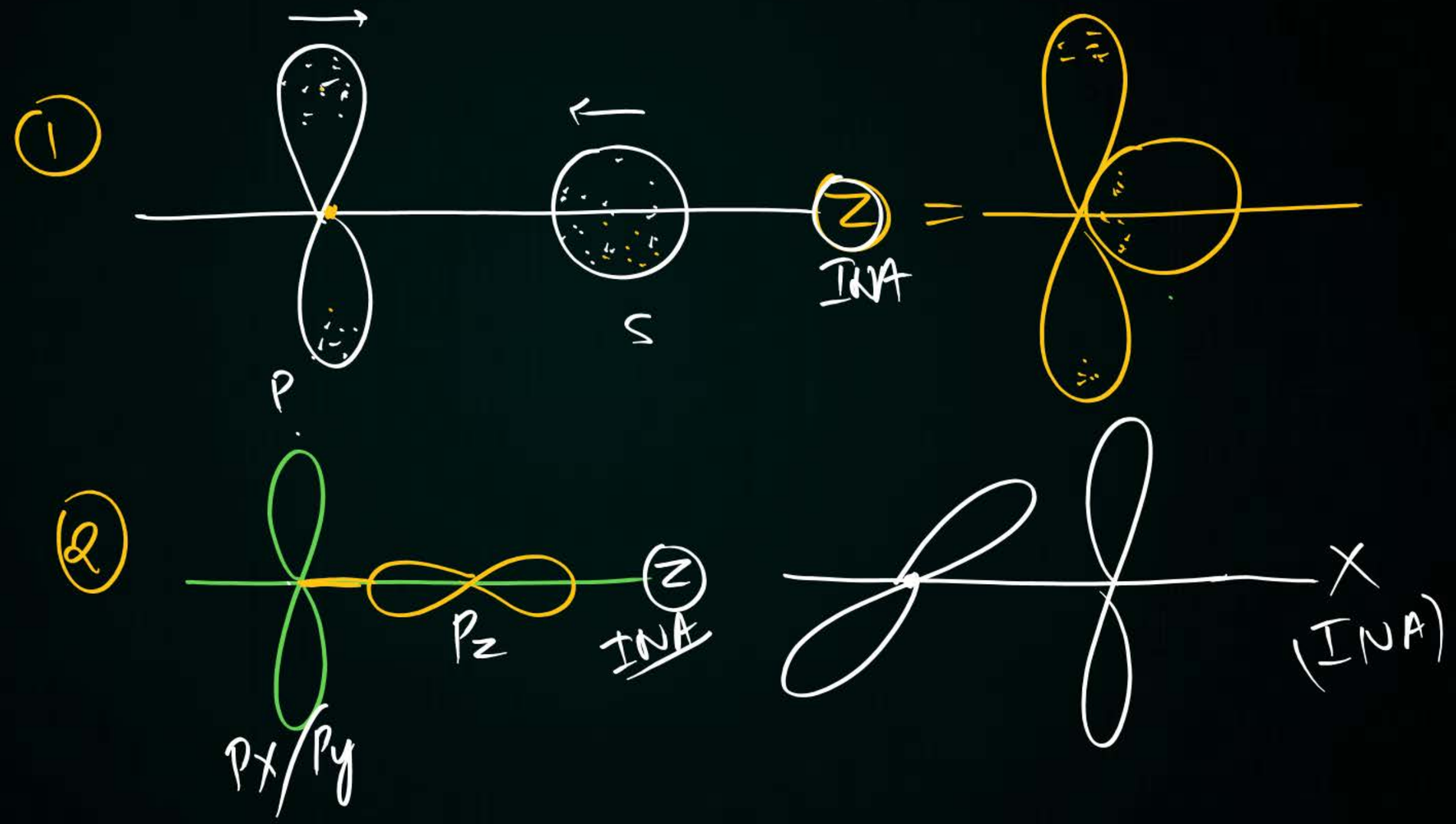
⇒ Negative overlapping.

Positive overlapping.

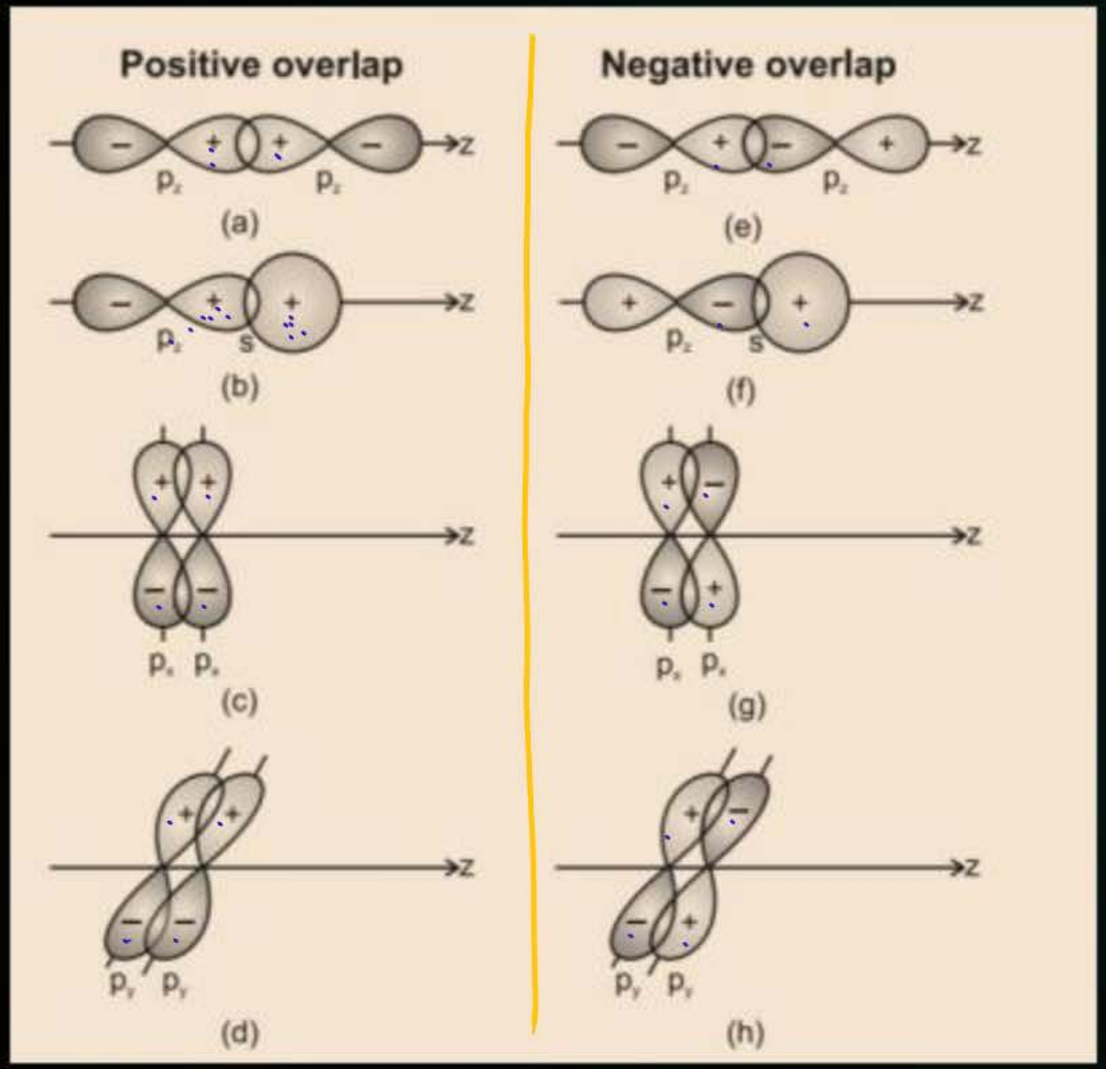

or
Positive overlapping.

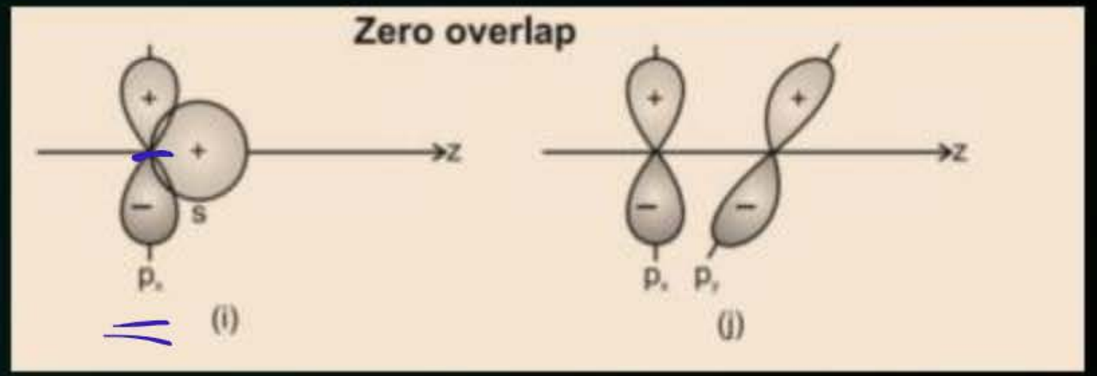

→ Achha.
→ Bura

Zero overlapping



Overlapping of Pure Atomic Orbitals





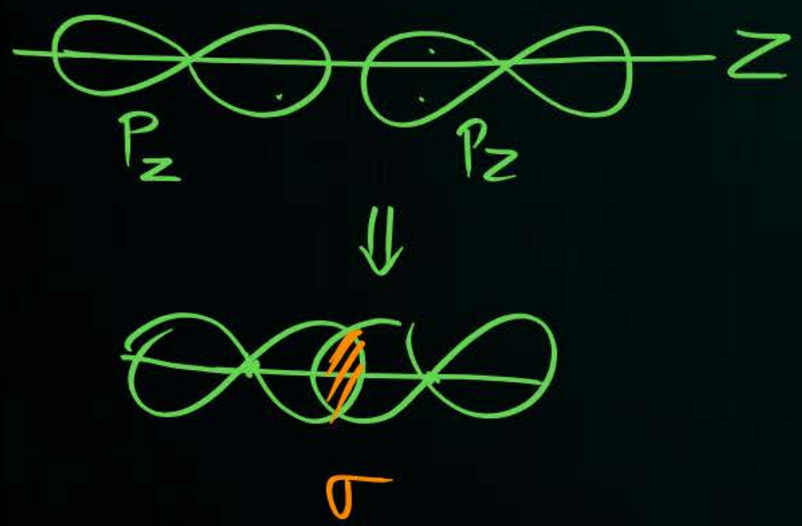
Types of Overlapping

NOTE σ Bond is stronger than π
∴ Overlapping Extent is more in Head on overlapping

Co-axial / Head-on overlapping

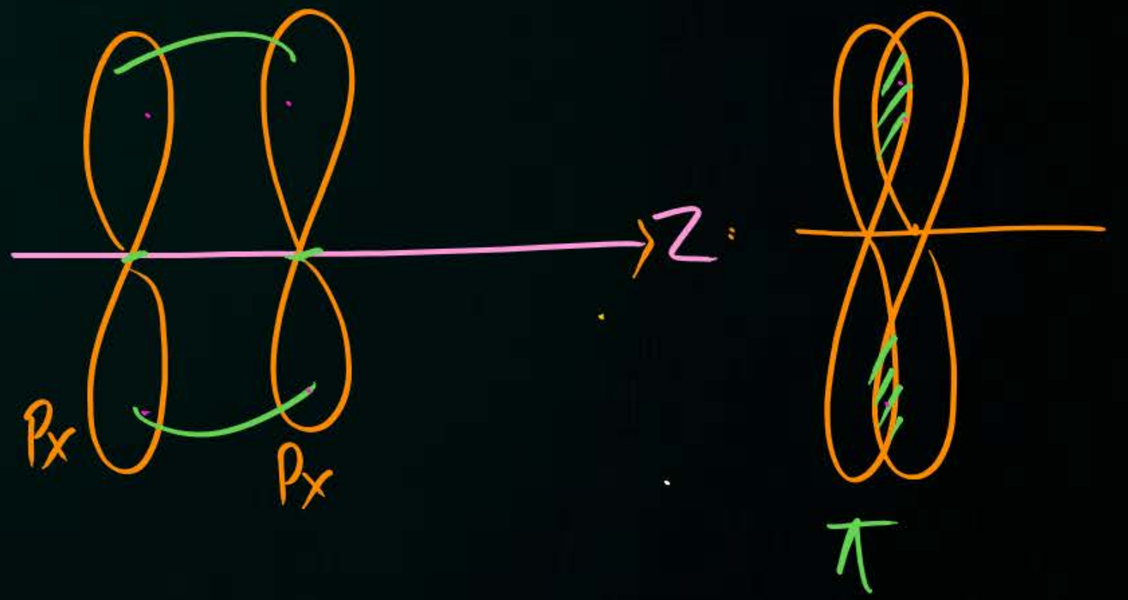
σ Bond Formation

Mixing Along the Internuclear axis (INA)



Collateral / Sideways overlapping

π Bond Formation.
Perpendicular to INA



$C-C < C=C < C\equiv C$ (Bond strength. or Bond Energy)

200

σ

$\sigma + \pi$

$200 + 100$

300

$\sigma + \pi + \pi$

$200 + 100 + 100$

400

Overlapping

Pure + Pure

$s + s \Rightarrow \sigma$

$s + p \Rightarrow \sigma / 0$

$p + p \Rightarrow \sigma / \pi / 0$

$p + d \Rightarrow \pi / 0$

$d + d \ \pi / 0$

Hybrid + Pure

Ex

$sp - s/p$

$sp^2 - s/p$

$sp^3 - s/p$

Bond = σ

Hybrid + Hybrid

Ex $sp^3 - sp^3$

$sp^2 - sp^2$

$sp - sp$

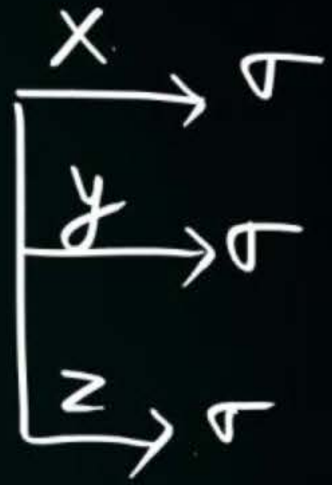
Bond $\Rightarrow \sigma$

Overlapping

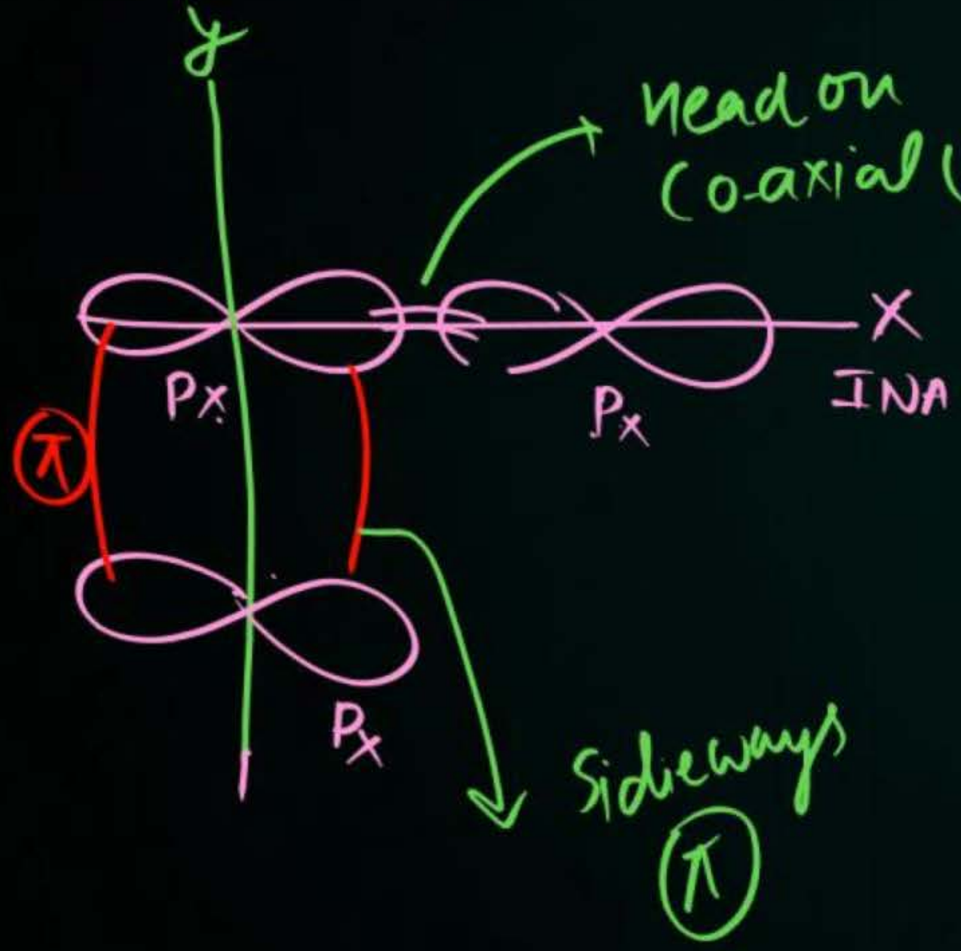
① s – s

INA

s, s



(2) p – p overlapping



$P_x + P_y$

X 0
Y 0
Z 0

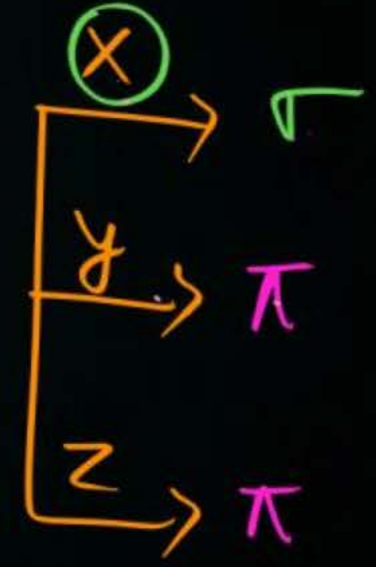
Both axis must be Same

MDJ **

Common par σ

Baki par π

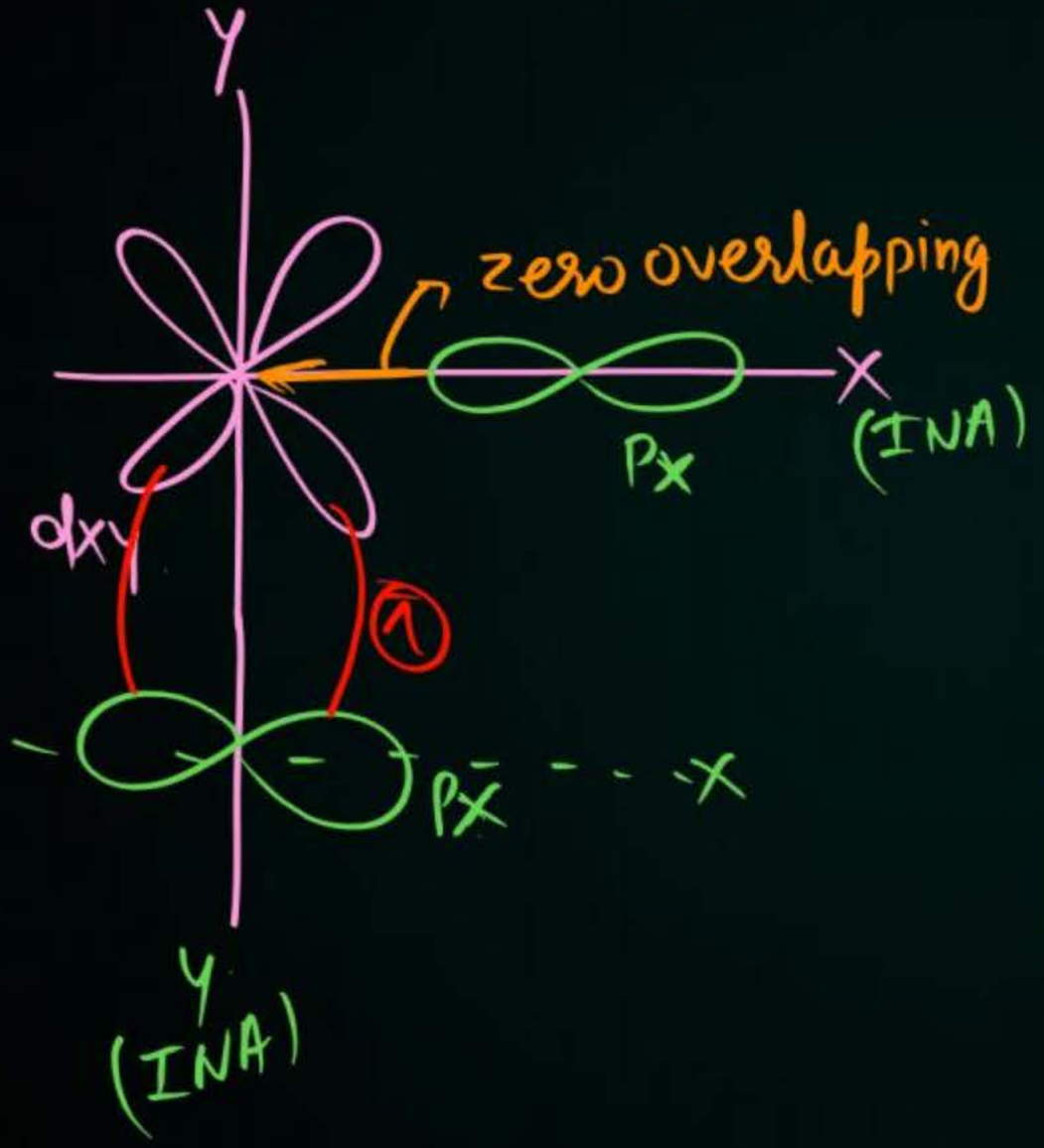
$P_{\otimes}, P_{\otimes}$



$P_{(y)}, P_{(y)}$

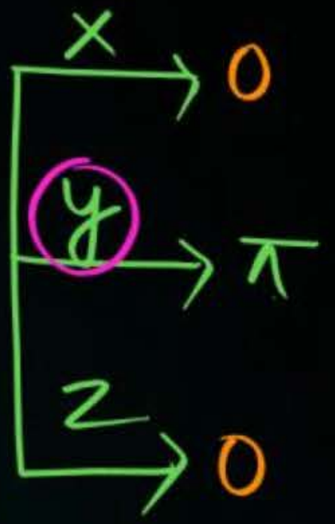
X π
(y) σ
Z π

(3) p-d overlapping



dx(y), Px

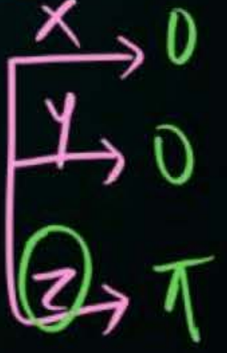
MDJ



In dono mai jo Uncommon axis hai Us par π

Baki zero

dyz(x), Py



d_{xy} , p_z

x → 0

y → 0

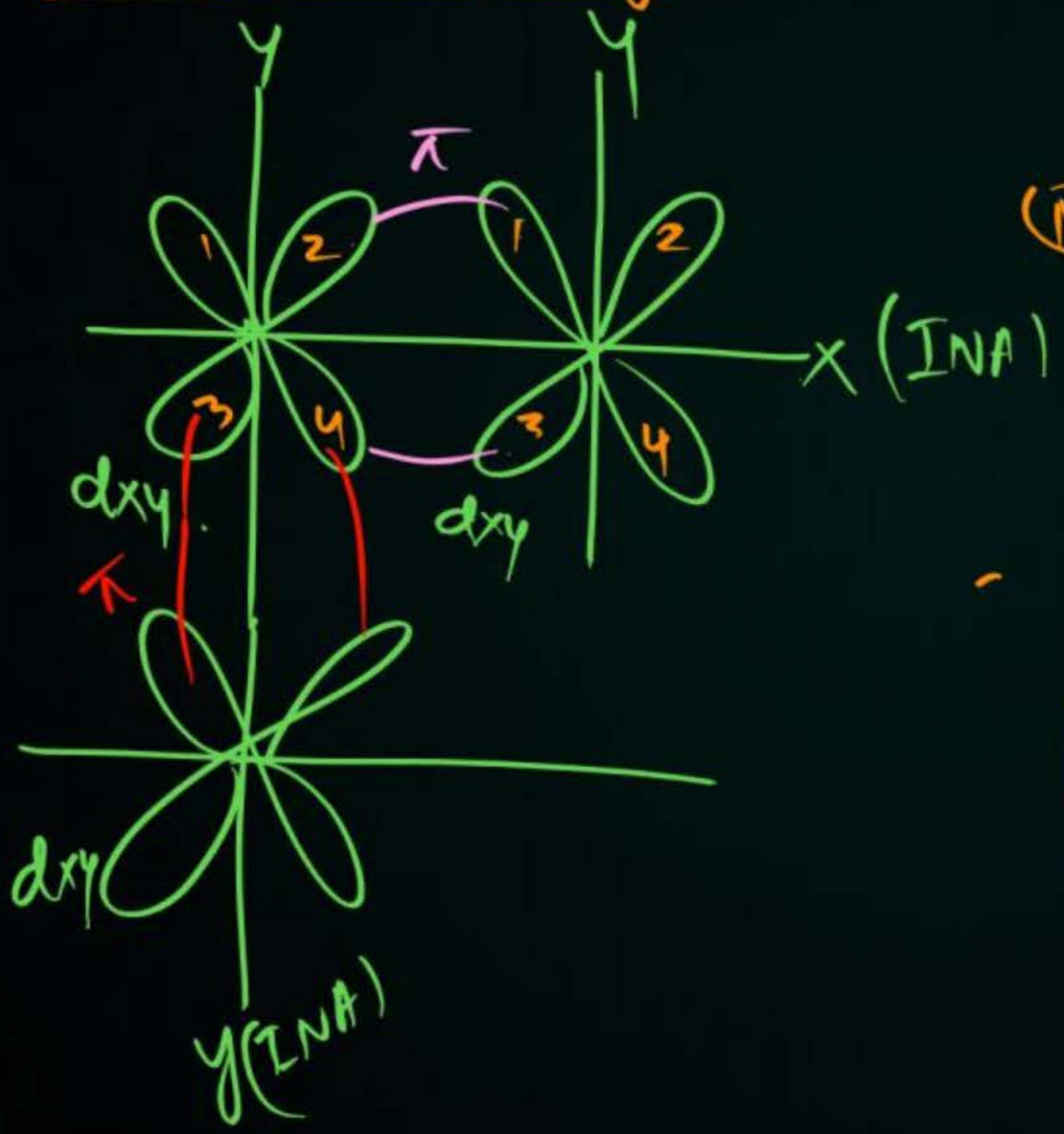
z → 0

Q

$d_{xz} + p_z \xrightarrow{INA = ?} \pi$

INA = X

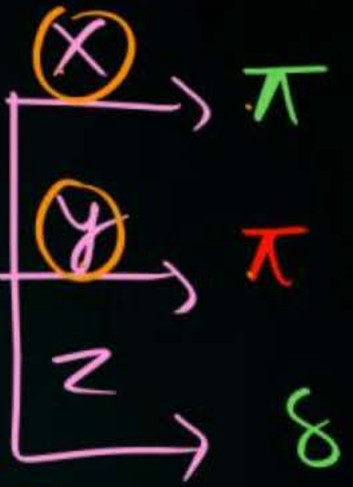
④ d-d overlapping



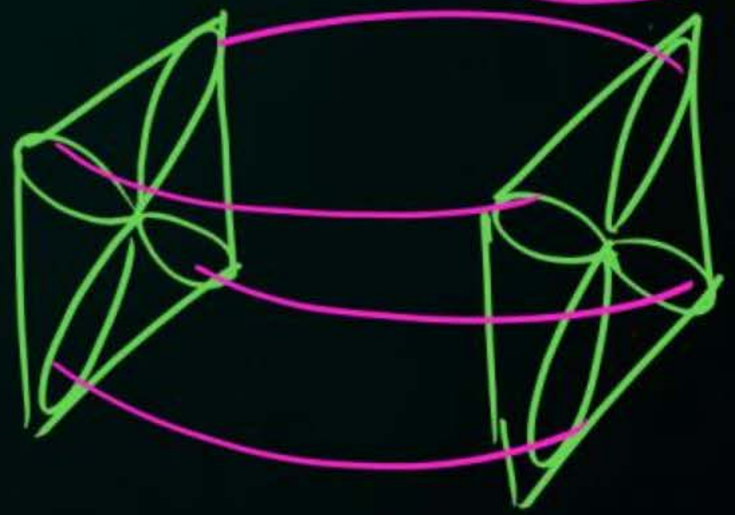
dxy . dxy

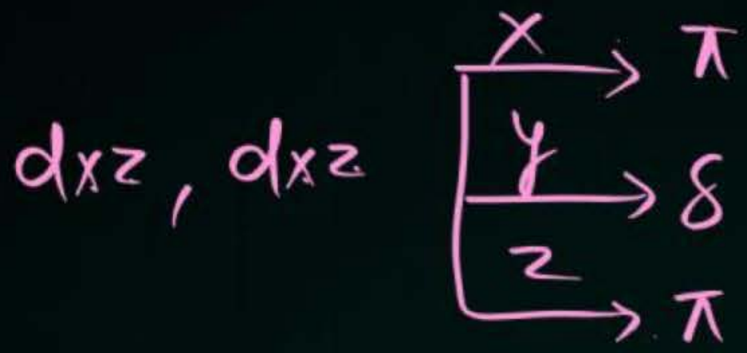
(MDJ)

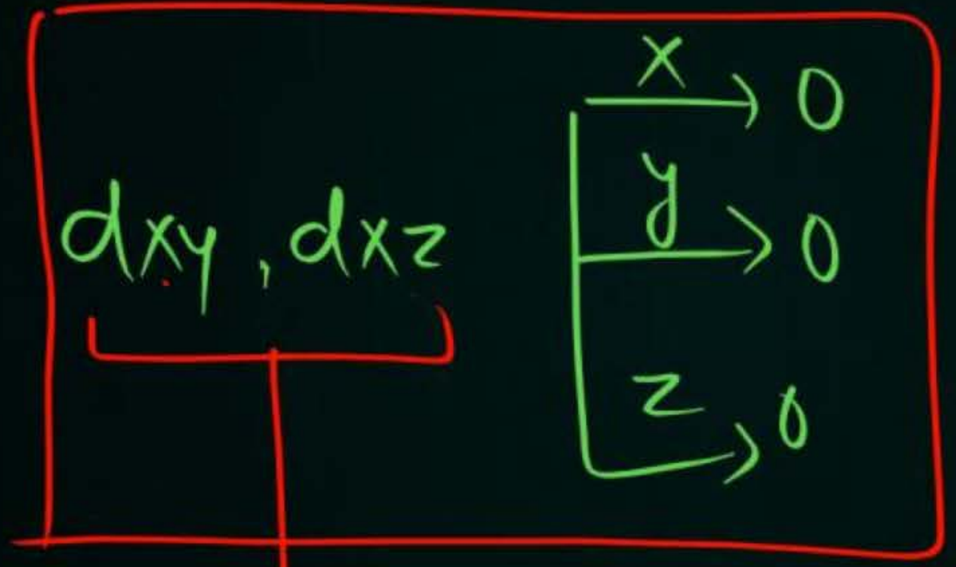
Common par
π baki par δ



δ Bond

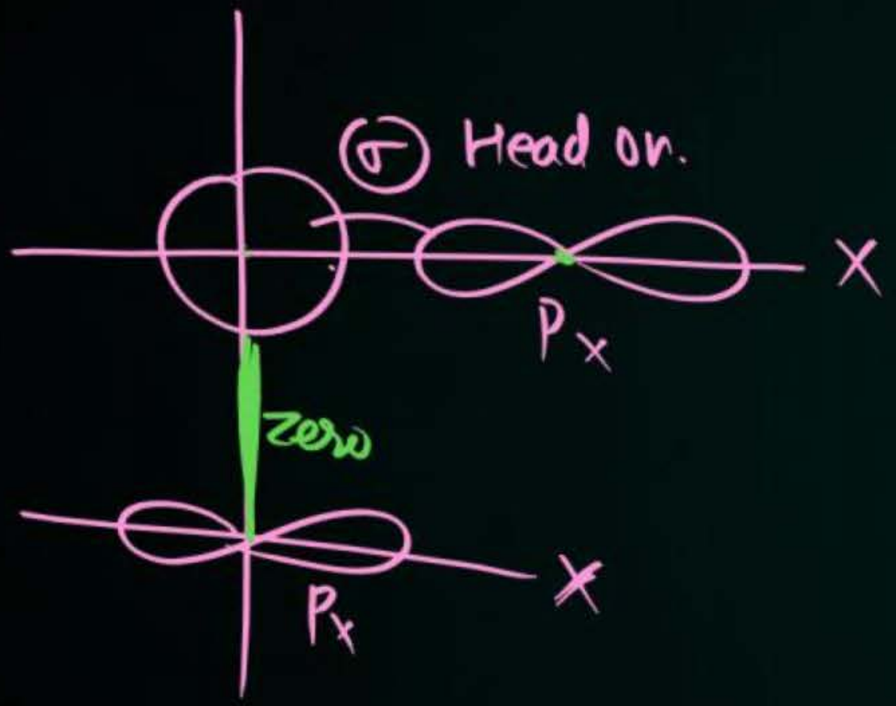






* Both d must be same

(5) S – P overlapping :-



S, P (X)

(X)	σ
Y	0
Z	0

(MDJ) Common par σ

Baki zero

S, P (Y)

X	0
(Y)	σ
Z	0

Home work

	(INA)	Type of Bond / zero
$P_x + P_x$	Y	
$P_y + P_x$	Z	
$P_z + P_z$	X	
$S + P_z$	Z	
$S + S$	Y	
$P_y + d_{xy}$	X	
$d_{xz} + d_{xz}$	X/Z	

Bond Identity :

Ex ① H_2

$H \underset{(\sigma)}{-} H$

1s — 1s or s–s

② $H-F$

1s – 2p or s– p

(σ)

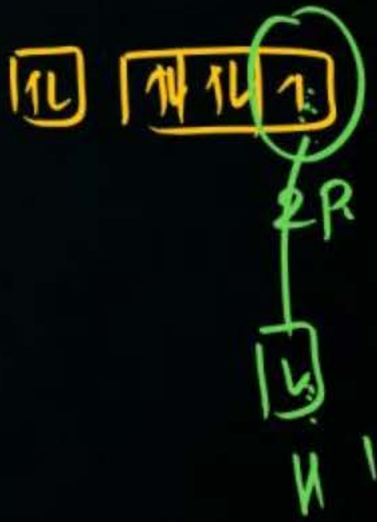
③ $F-F$

2p – 2p (σ)

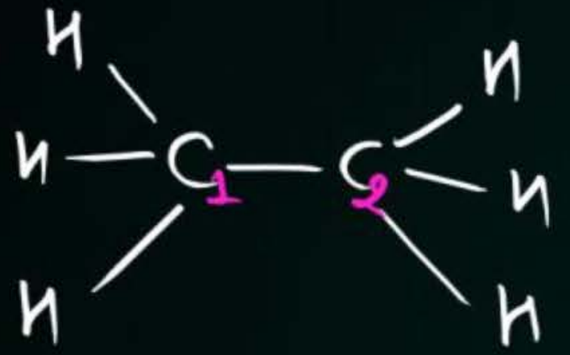
④ $Cl-Cl$

3p – 3p (σ)

F $2s^2 2p^5$



(5) $CH_3 - CH_3$

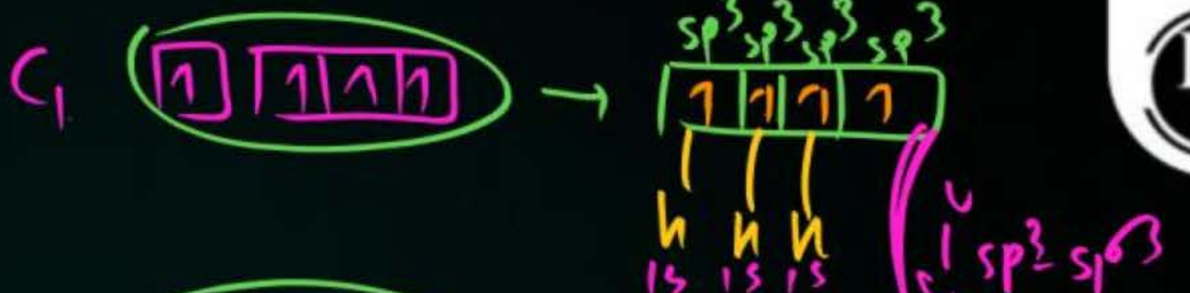


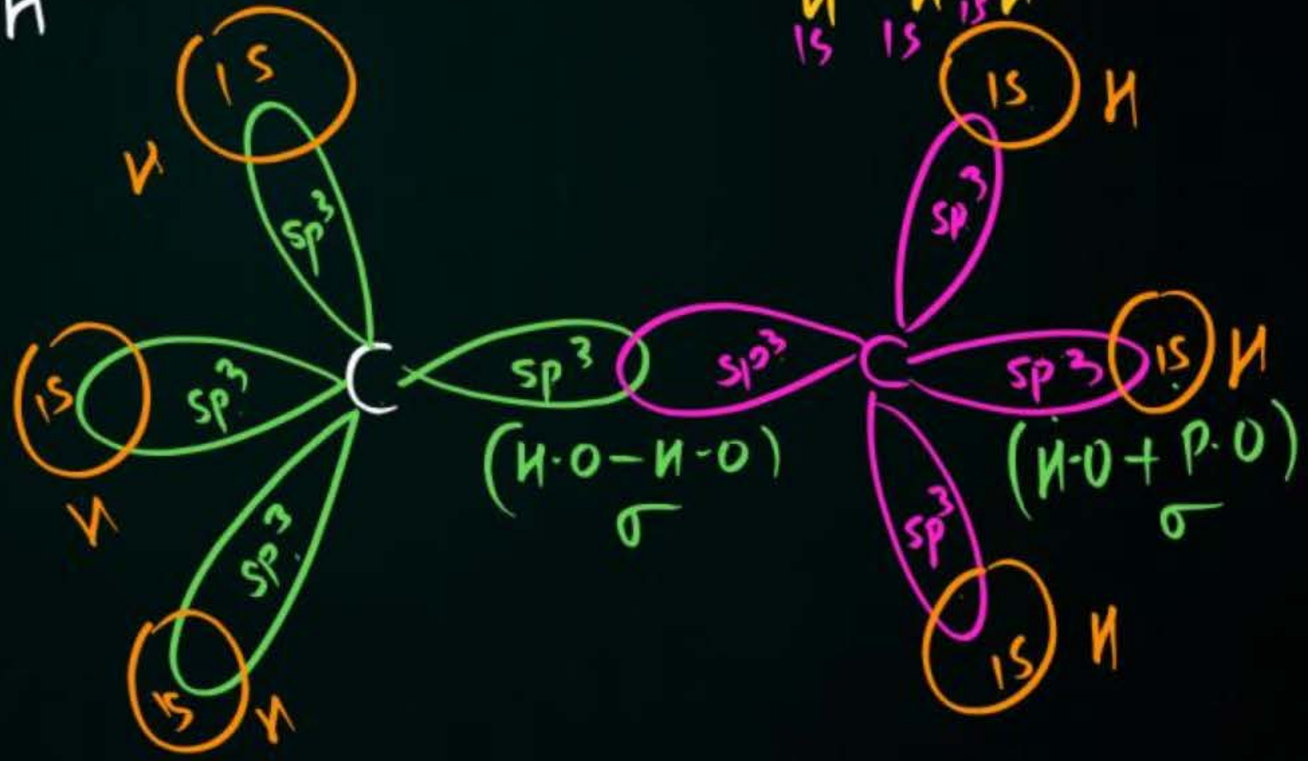
(one)

(σ) C – C (sp^3 – sp^3)

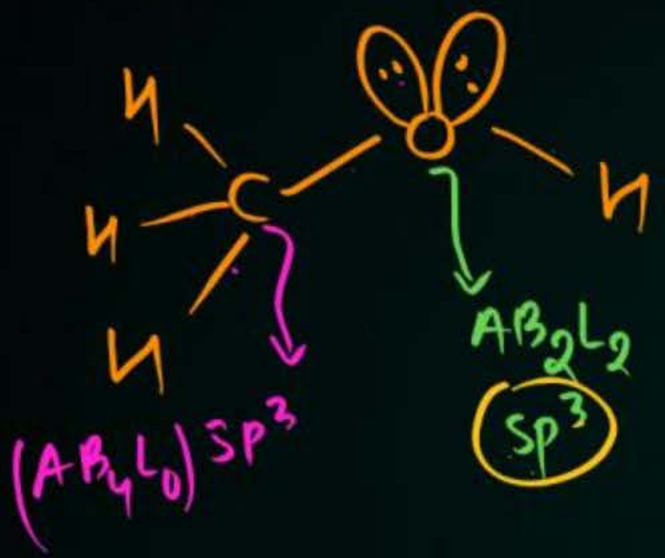
(σ) C – H (sp^3 – 1s)

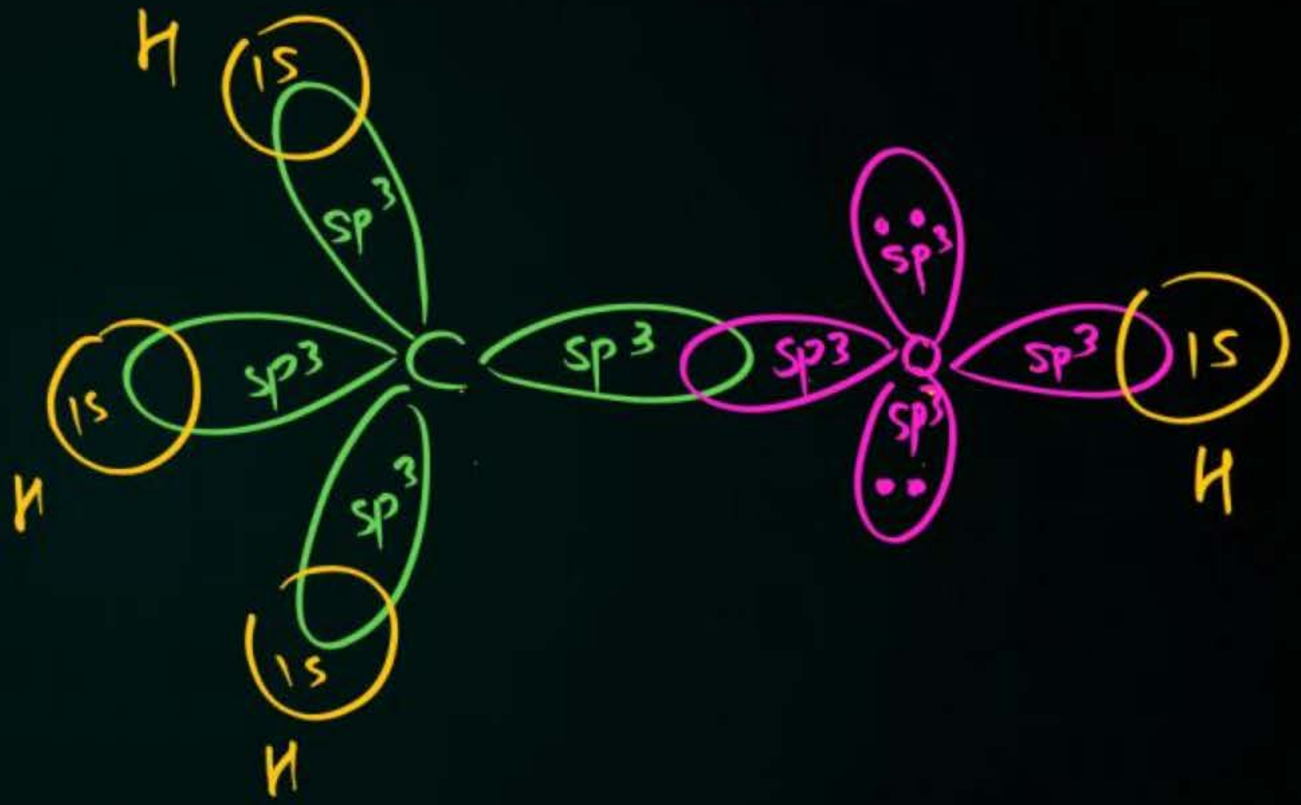
(six)





(6) CH_3OH



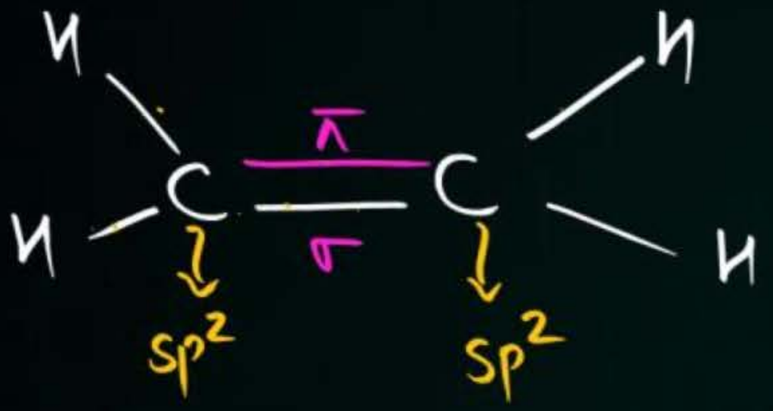


(One) C — O (σ)
$sp^3 - sp^3$

(three) C — H (σ)
$sp^3 - 1s$

(one) O — H (σ)
$sp^3 - 1s$

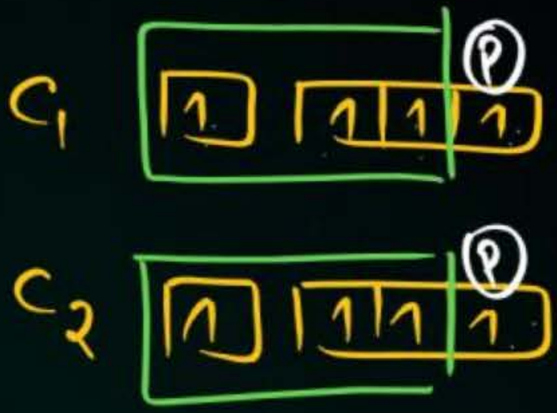
(7) $CH_2 = CH_2$

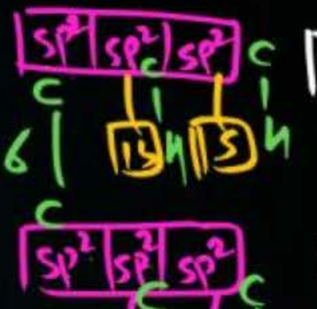


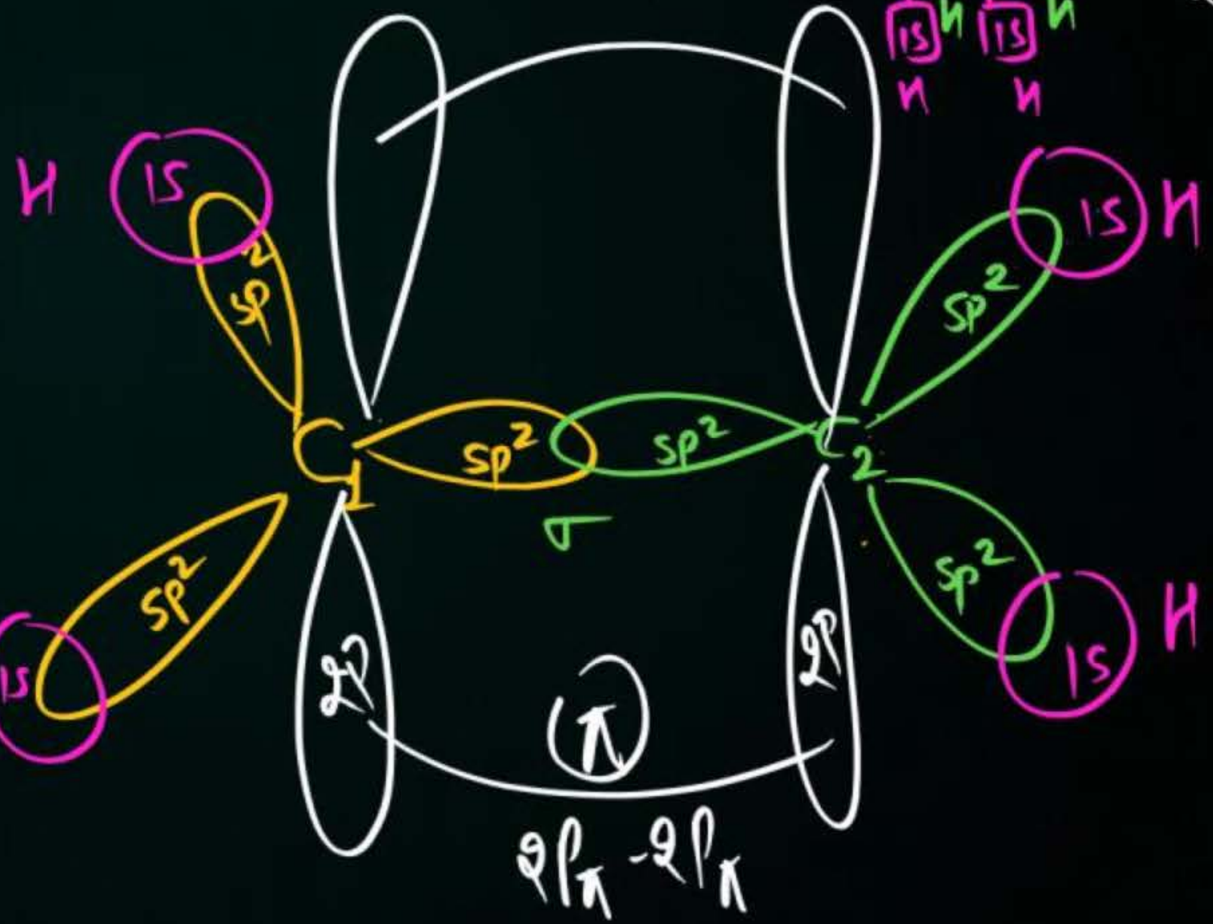
(one) σ $sp^2 - sp^2$ $(C \underset{\sigma}{-} C)$

(Four) σ $sp^2 - 1s$ $(C - H)$

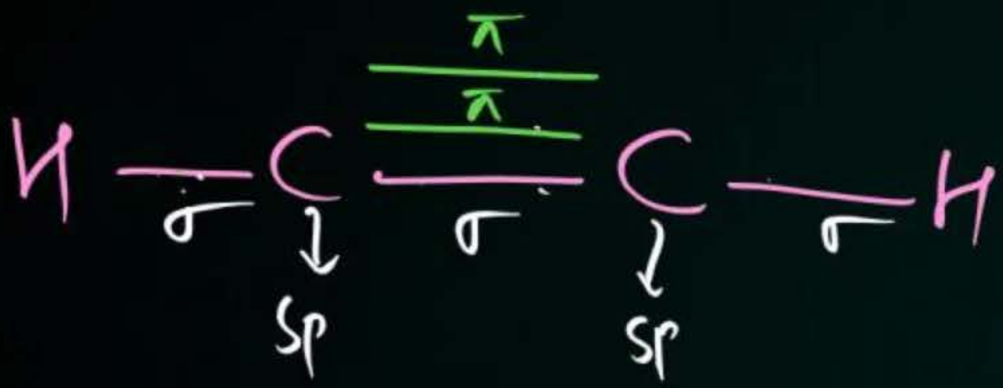
(One) π $2p - 2p$ $(C \underset{\pi}{-} C)$

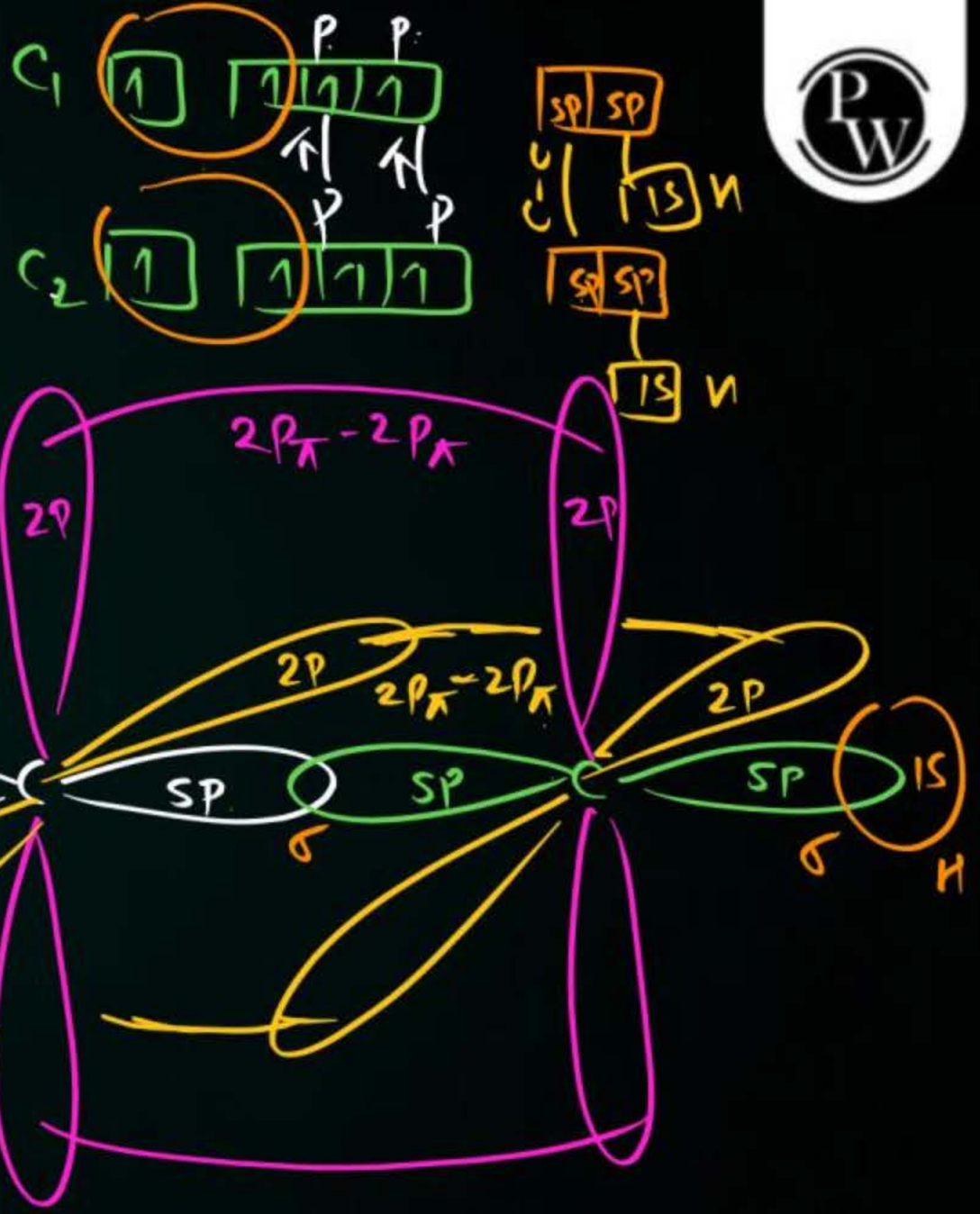






⑧ $CH \equiv CH$

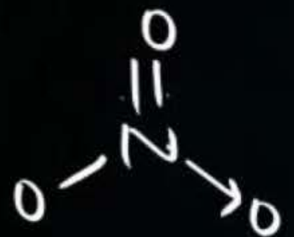



C1
C2
1
P
P
P
P
sp sp
C
C
1S H
sp sp
1S H
2p
2p
2p

MDJ For (π) identity

→ (i) if C.A belongs to 2nd Period then $p\pi - p\pi$ always

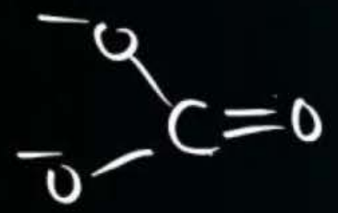
$\therefore$ ~~3d~~ ~~$d\pi$~~ ~~$f\pi$~~



SO_3^{2-} sp^3 AB_3L_1

NO_3^- $p\pi - p\pi$

NO_2^-



CO_3^{2-} $p\pi - p\pi$

$d\pi - p\pi$ ←

ClO_4^- sp^3 AB_4L_0

ClO_3^- sp^3 AB_3L_1

ClO_2^- sp^3 AB_2L_2

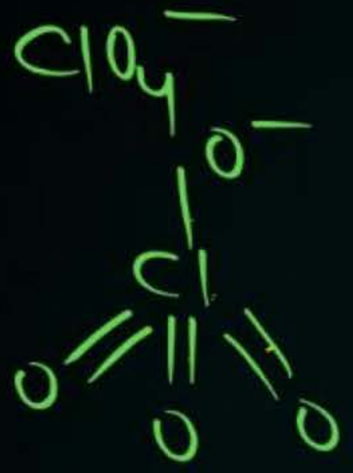
SO_4^{2-} sp^3 AB_4L_0

PO_4^{3-} sp^3

(ii) If Hybridisation is (sp) then all are $p\pi - p\pi$

(iii) If Hybridisation is sp^2 (s+p+p+p) then One is $p\pi - p\pi$ rest are $d\pi - p\pi$

(IV) If Hybridisation is (sp^3) or other all are $d\pi - p\pi$ (s+p+p+p)



sp^3

Three

$d\pi - p\pi$

ClO_3^-

sp^3

AB_3L_1

two $(d\pi - p\pi)$

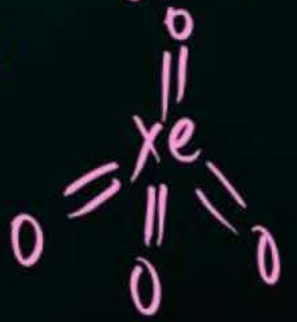
HW

ClO_2^-

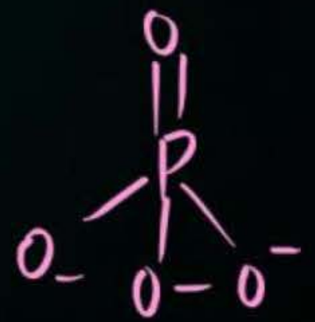
SO_3^{2-} sp^3

XeO_3 sp^3

NO_2^-



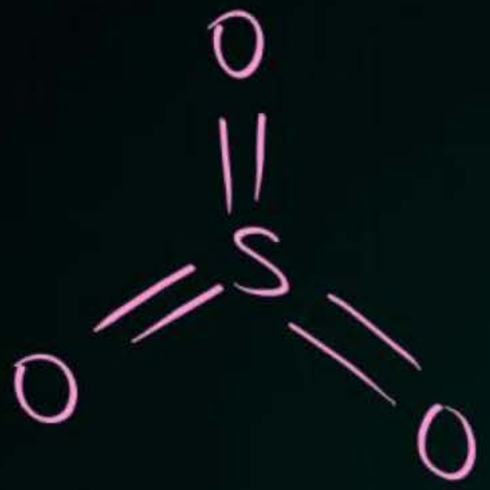
XeO_4 sp^3



SO_4^{2-} sp^3

PO_4^{3-} sp^3

SO_3



AB_3L_0 → sp^2 (s+p-hp) (p pure)

- One $p_\pi - p_\pi$
- Rest are $d_\pi - p_\pi$

} MDJ

Total $\pi = 3$

$p_\pi - p_\pi = 2$

$d_\pi - p_\pi = 2$

SO_2

AB_2L_1

sp^2

1 $P_\pi - P_\pi$

Rest are $d_\pi - P_\pi$

Total $\Rightarrow 2\pi$

One is $P_\pi - P_\pi$

One is $d_\pi - P_\pi$

QUESTION

$d\pi - p\pi$ or

Which of the following has $p\pi - d\pi$ bonding :

A NO_3^-

B SO_3^{-2}

C BO_3^{-3}

D CO_3^{-2}

Bond Strength :

(i) Bond strength $\propto \frac{1}{\text{size (shell no.)}}$ (P.Q.N)

1S–1S (n=1) > 2S–2S (n=2) > 3S–3S (n=3)

Size ↑ Strength ↓

* If size same : s-s < s-p < p-p 2S–2S < 2S–2P < 2P–2P

In Case of σ Bond (Co-axial) (B.S ∝ directional Nature)

* If size same : 3pπ-3pπ < 3pπ-3dπ < 3dπ-3dπ

In Case of π (Collateral) (B.S ∝ Extent of overlapping area)

(ii) Lone pair lone pair repulsion can show exceptions only in second period. elements & In Case of Single Bonded atoms

Ex (valid in) N–N O–O F–F

Compare Bond Strength in following :

i. 1s-1s > 2s-2s > 3s-3s

ii. 2s-2s < 2s-2p < 2p-2p (directional nature)

iii. 1s-2s < 1s-2p (size same, B.S ∝ directional nature)

iv. p-p (Co-axial) > p-p(collateral)

v. N-N < P-P

vi. O-O < S-S

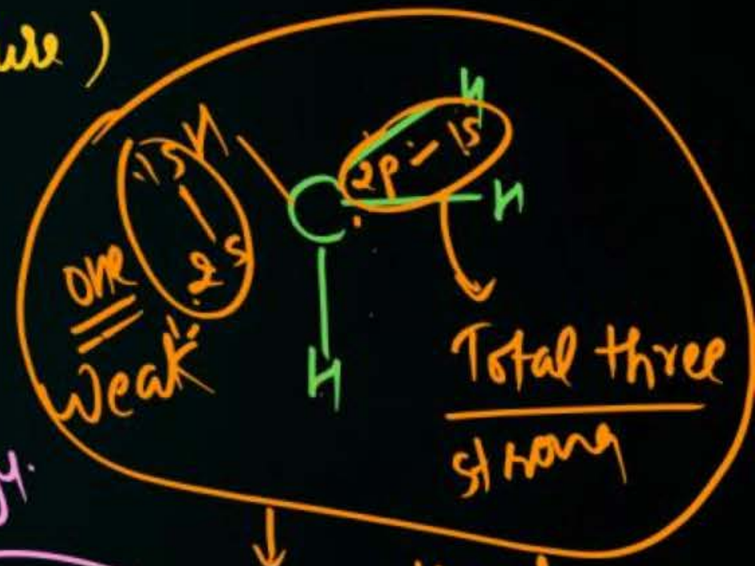
vii. F-F < Cl-Cl > Br-Br > I-I

l.p - l.p repulsion

Very. V. Imp

Bond strength or Bond Energy ↑

$Cl_2 > Br_2 > F_2 > I_2$



CH_4 without Hybridisation

Size same

	①			⑤
viii.	1s-1s	2s-2s	2s-2p	2p-2p	3s-3s
		④	③	②	
ix.	3pπ-3pπ	< 3pπ-3dπ	< 3dπ-3dπ		
		③	②	④	
x.	2pπ-2pπ	3pπ-3dπ	3dπ-3dπ	3pπ-3pπ	
	①				

same size

Weakest

Exist

1 > 2 > 3 > 4 > 5

N ≡ N

✓ Exist

✓ $2p_\pi - 2p_\pi$ strong

P ≡ P

Exist

∵ $3p_\pi - 3p_\pi$ Exist

QUESTION

Nitrogen form N_2 but phosphorous do not exist as P_2, at room temp. because :

(A) Triple bond present between phosphorous atom

(B) $p_\pi - p_\pi$ bonding is weak

(C) $p_\pi - p_\pi$ bonding is strong

(D) Multiple bond form easily

Homework

give Correct order of Bond strength in following

1. C-C Si-Si Ge-Ge Sn-Sn
2. C-C C=C C≡C
3. N-N N=N N≡N
4. C=N C≡N
5. C=O C≡O
6. O-O O=O
7. H-F H-Cl H-Br H-I

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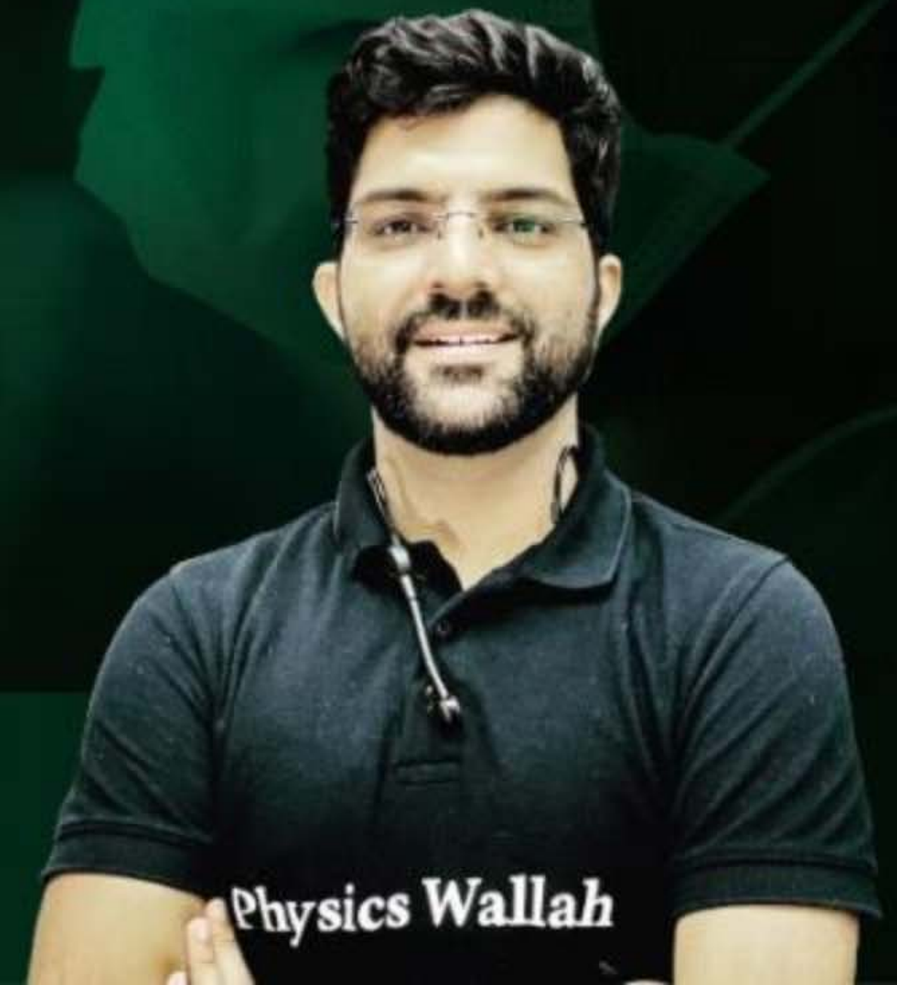
FOR NEET 2025

Lecture - 08 | Inorganic Chemistry

Chemical Bonding & Molecular Structure

By - Mohit Dadheech (MD Sir)



Topics *to be covered*

1. Bond Parameters
   - Bond length
   - Bond Enthalpy
   - Bond angle
   - Bond order

Bond Parameters :

Experimental Data

1. Bond Length

Inter Nuclear Distance

- Bond length is defined as the equilibrium distance between the nuclei of two bonded atoms in a molecule.

- The covalent radius is measured approximately as the radius of an atom's core which is in contact with the core of an adjacent atom in a bonded situation.

- The van der Waals radius represents the overall size of the atom which includes its valence shell in a nonbonded situation.

O > N > O > F (Size)

Bond Type	Covalent Bond Length (pm)
O–H	96
C–H	107
N–O	136
C–O	143
C–N	143
C–C	154 ✓
C=O	121
N=O	122
C=C	133 ✓
C=N	138
C≡N	116
C≡C	120 ✓

C (C–C) (C=C) C≡C (B.L)

Molecule	Bond Length (pm)
H_2 (H – H)	74
F_2 (F – F)	144 ✓
Cl_2 (Cl – Cl)	199 ✓
Br_2 (Br – Br)	228 ✓
I_2 (I – I)	267 ✓
N_2 (N ≡ N)	109
O_2 (O = O)	121
HF (H – F)	92
HCl (H – Cl)	127
HBr (H – Br)	141
HI (H – I)	160

N_2: 3.0, 3.0 — O_2: 2.0, 3.0

HF < HCl < HBr < HI (B.L)

F_2 Cl_2 Br_2 I_2 (Bond strength / Bond Energy)

$Cl_2 > Br_2 > F_2 > I_2$

F_2 → l.p-l.p repulsion

But

$F_2 < Cl_2 < Br_2 < I_2$ (Bond length)

B.O = 2

2. Bond Order

- In the Lewis description of covalent bond, the Bond Order is given by the number of bonds between the two atoms in a molecule.

- Isoelectronic molecules and ions have identical bond orders; for example, F_2 and O_2^{2-} have bond order 1. N_2, CO and NO^+ have bond order 3.

18e⁻ 14e⁻, 14e⁻, 14e⁻ 18e⁻

- A general correlation useful for understanding the stablities of molecules is that: with increase in bond order, bond enthalpy increases and bond length decreases.

gen

$$B.O \propto B.S \propto \frac{1}{B.L}$$

CO
6 + 8 = 14 e⁻

CN⁻
6 + 7 + 1 = 14 e⁻

Isoelectronic

3. Bond Enthalpy

- It is defined as the amount of energy required to break one mole of bonds of a particular type between two atoms in a gaseous state.

- In case of polyatomic molecules, the measurement of bond strength is more complicated. For example in case of H_2O molecule, the enthalpy needed to break the two O – H bonds is not the same.

- Therefore in polyatomic molecules the term mean or average bond enthalpy is used. It is obtained by dividing total bond dissociation enthalpy by the number of bonds broken.

$H_2O \longrightarrow H + OH \quad 502\ kJ\,mol^{-1}$

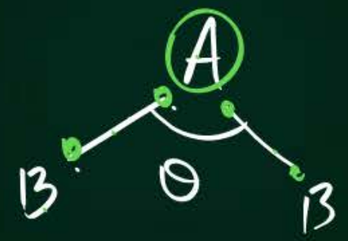
$OH \longrightarrow H + O \quad 427\ kJ\,mol^{-1}$

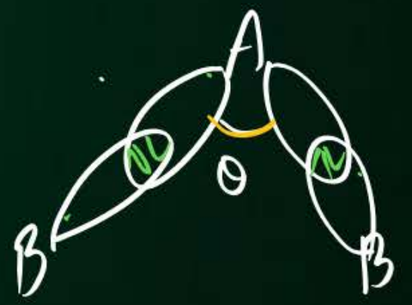
Avg $\dfrac{502 + 427}{2}$

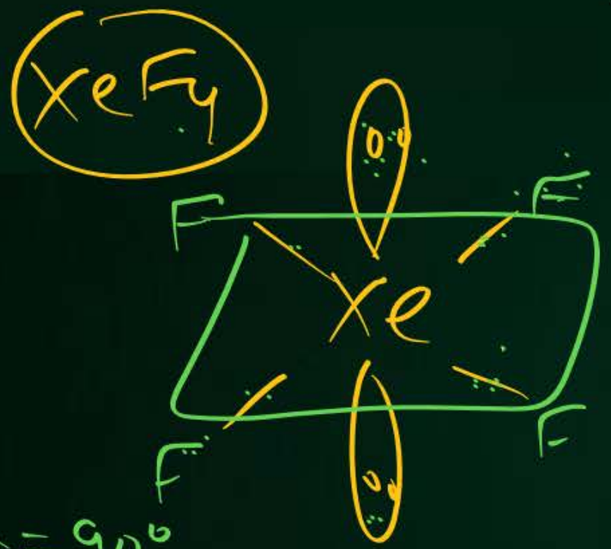
$464.5\ kJ\,mol^{-1}$

2. Bond Angle

- It is defined as the angle between the orbitals containing bonding electron pairs around the central atom in a molecule/complex ion. Bond angle is expressed in degree which can be experimentally determined by spectroscopic methods.





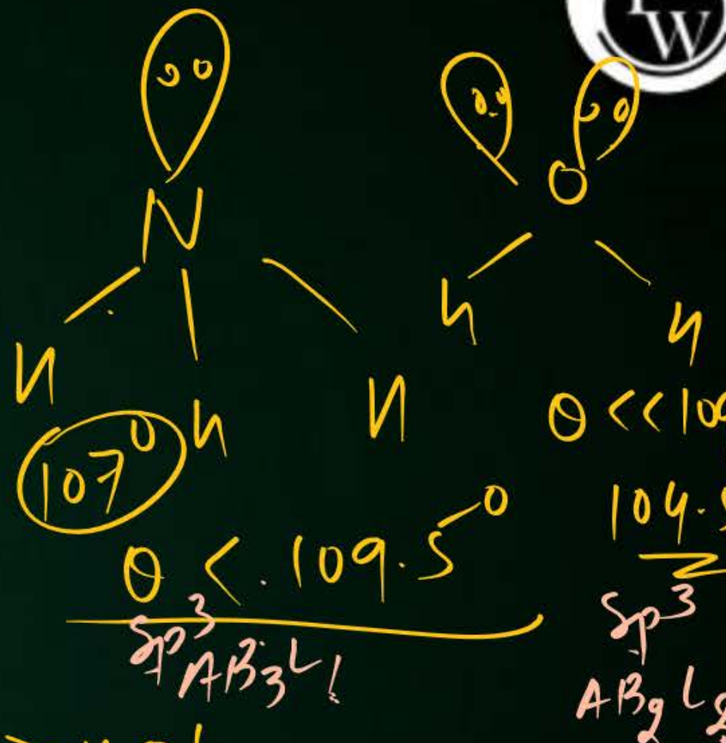


adj. $\theta = 90^\circ$

109.5°

sp^3

AB_4L_0



$\theta < 109.5^\circ$

sp^3

AB_3L_1

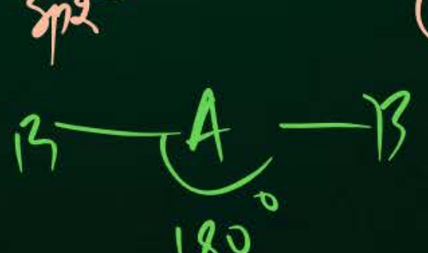
sp^3

AB_2L_2

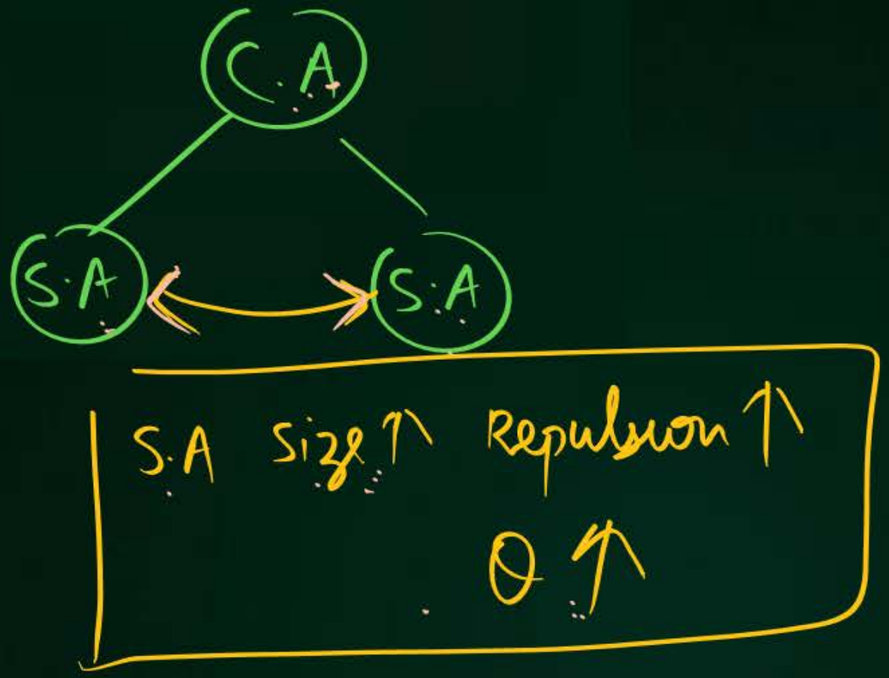
$CO_2 > BF_3 > CH_4 > NH_3 > H_2O$

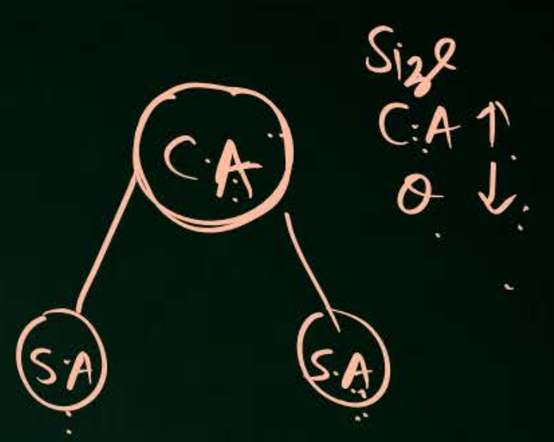
sp sp2 sp3

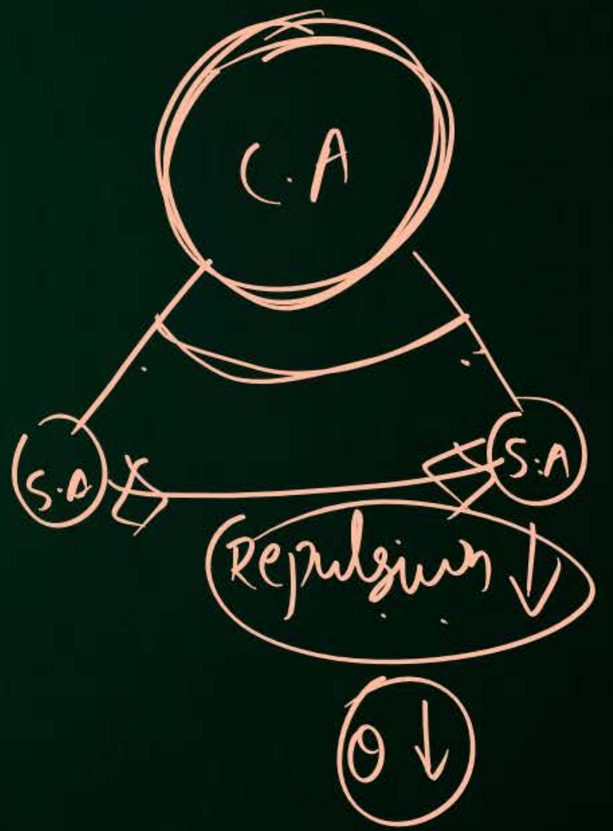
All possible $\theta =$ 90 & 180°



linear


C.A
S.A
S.A
S.A size ↑ Repulsion ↑
θ ↑


Size
C.A ↑
θ ↓
C.A
S.A
S.A


C.A
S.A
S.A
Repulsion ↓
θ ↓

Bond Angle :

Step by step

MDI

Trick to find Bond Angle

VSEPR → Shape → linear Max θ = 180°

→ AB_2L_0 , AB_2L_3

Hybridisation $SP > sp^2 > sp^3$ (% s)

$180° > 120° > 109.5°$ s ↓ θ ↓

If Hybridisation is same

l.p lagao Angle ghatao

If lone pair is present at central atom

No. of L.P. ↑ Bond angle ↓

If L.P. and hybridisation both are same

- Size of surrounding atom ↑ bond angle ↑
- Size of central atom ↑ bond angle ↓

If lone pair is absent at central atom

Give answer acc. to hybridisation

$BF_3 = BCl_3 = BBr_3$

AB_3L_0, sp^2

Q Compare Bond Angle in Following Species :-

(1) $CO_2 = XeF_2$

AB_2L_0 — linear

AB_2L_3 — linear

(2) $CS_2 > SO_2$

CS_2: AB_2L_0, linear

SO_2: AB_2L_1, Bent

(3) BF_3 CO_2 CH_4

BF_3: AB_3L_0, sp^2

CO_2: AB_2L_0, sp

CH_4: AB_4L_0, sp^3

$CO_2 > BF_3 > CH_4$

(Imp) (4) $CH_4 > NH_3 > H_2O$

CH_4: sp^3, AB_4L_0

NH_3: sp^3, AB_3L_1

H_2O: sp^3, AB_2L_2

⑤ $CCl_4 = SiCl_4$

AB_4L_0, sp^3

Hyb same

l·p absent at C·A

~~C·A~~ ~~O·A~~

⑥ $CO_2 > SiO_2$

Special case →

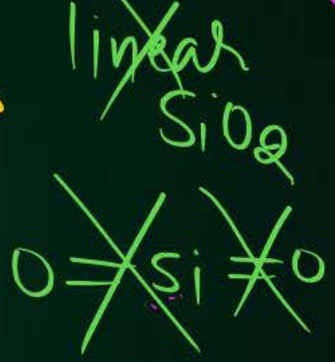
SiO_2

All 4 "O" are shared.

3D Silicate

linear

SiO_2



tetrahedral

109.5°

CO_2

(7) $NF_3 < NCl_3 < NBr_3$

AB_3L_1, sp^3

Hyb same
no. of l.p same
C.A same.
S.A ↑ θ ↑

(8) NCl_3 PCl_3 $AsCl_3$

AB_3L_1, sp^3

C.A diff C.A ↑ θ ↓

Hyb same.
no. of l.p same
S.A same.

QUESTION

Correct order of bond angle is / are :

1. $SO_2 = CO_2$ ✗

2. $NO_2^- > NO_2^+$ ✗

Bent AB_2L_1 — linear AB_2L_0

3. $NO_3^- < N_3^-$

AB_3L_0 — AB_2L_0 linear

$120^\circ < 180^\circ$

4. $CH_4 < NH_4^+$ ✗

AB_4L_0 sp^3 — AB_4L_0 sp^3

$CH_4 \equiv NH_4^+$

QUESTION

In which of the following change, adjacent bond angle increases?

1. $BeF_2 + 2F^- \longrightarrow BeF_4^{2-}$
   AB_2L_0 180° → AB_4L_0 109.5°
2. $SiF_4 + 2F^- \longrightarrow SiF_6^{2-}$
   AB_4L_0 109.5° → AB_6L_0 90°
3. $BF_3 + F^- \longrightarrow BF_4^-$
   AB_3L_0 120° → AB_4L_0 109.5°
4. $NH_3 + H^+ \longrightarrow NH_4^+$
   AB_3L_1 107° → AB_4L_0 109.5°

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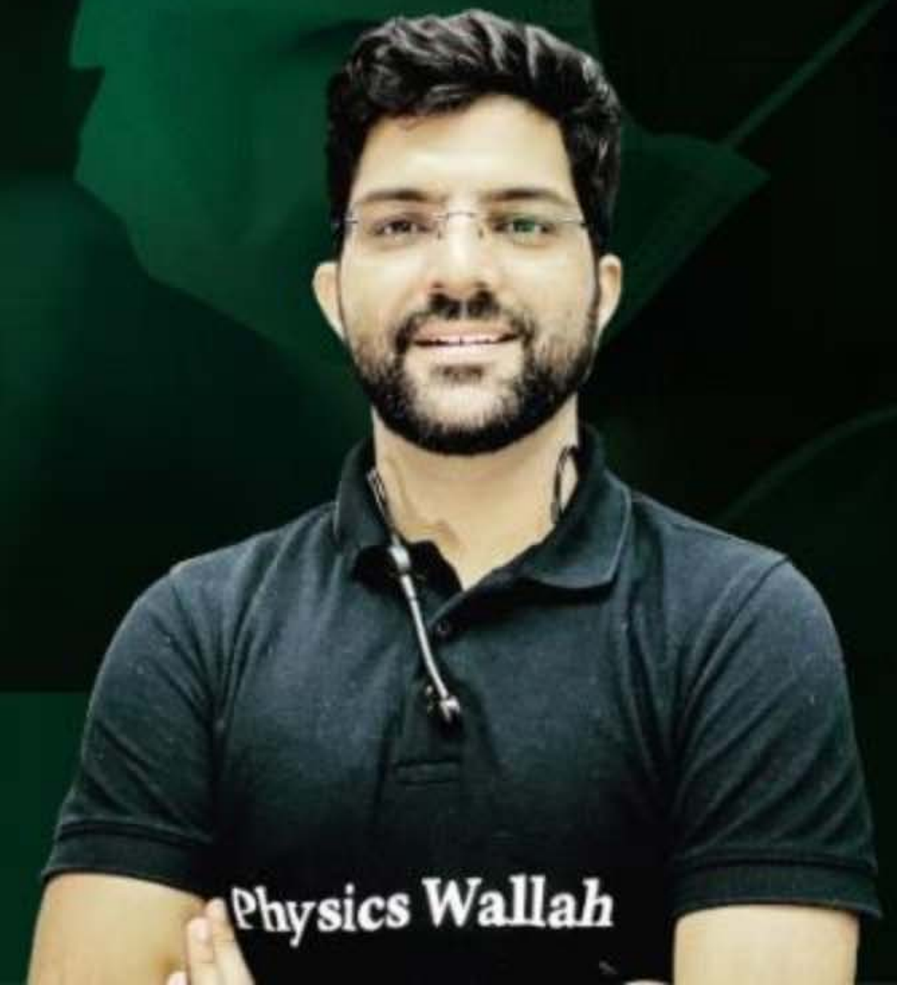
FOR NEET 2025

Lecture - 09 | Inorganic Chemistry

Chemical Bonding & Molecular Structure

By - Mohit Dadheech (MD Sir)



Topics *to be covered*

1. Some Important Points

Some Important Points

- Hybridisation in odd e^- species
- Existing & Non-Existing molecules
- Solid state hybridisation in some important species

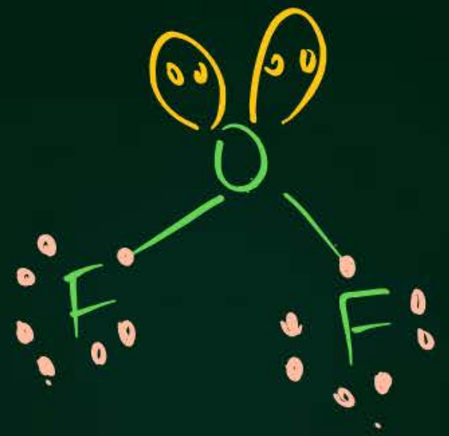
Not in NCERT

OF_2 Total l.p & B.p

Total

B.p → σ + π

l.p → All atoms



Total l.p = 8

Total B.p → σ + π
2 + 0 = 2

σ Bond

AB_2L_2 → l.p at Central atom

Central atom

I_3^-

Total l.p

9

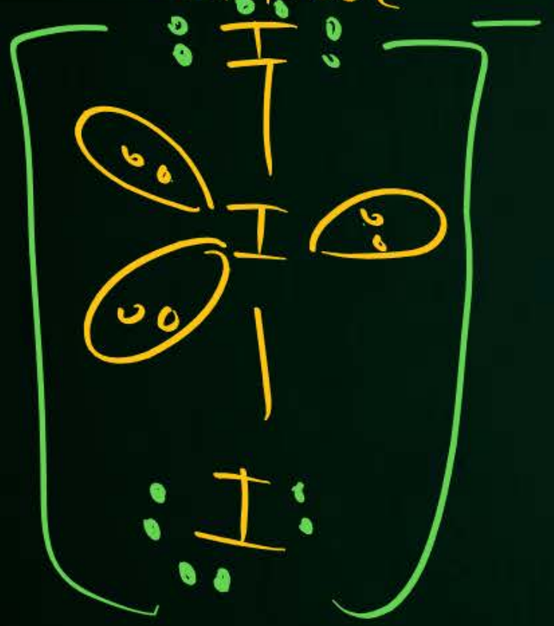
l.p at Central atom

3

JEE Mains

AB_2L_3

linear



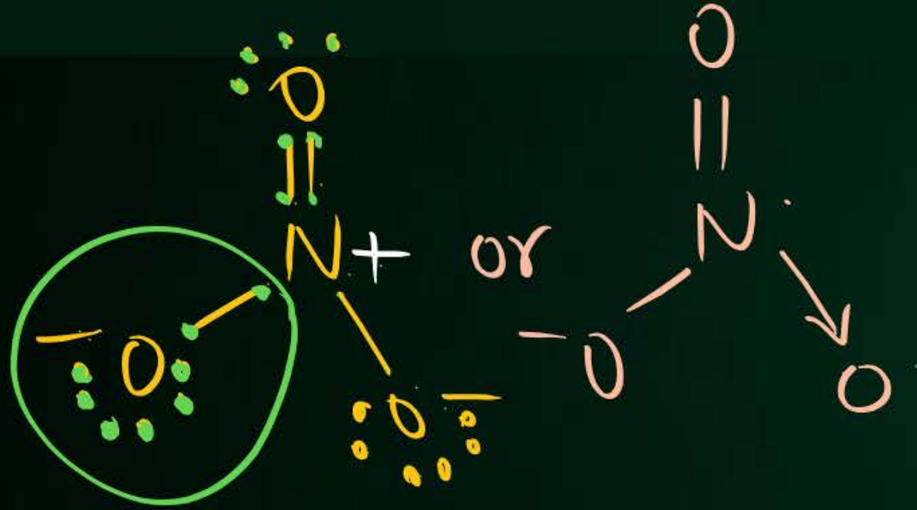
NO_3^-

Total l.p

Total B.p ($\sigma + \pi$)

l.p at Central atom

AB_3L_0



8

$3\sigma + 1\pi$

4

0

$-2+1=(-1)$

Q. How many Bond pair & l.p are present in NO_3^- respectively

1. 3, 0
2. 3, 1
3. 5, 8
4. 2, 2

Hybridisation in some important odd e⁻ species

Orbital having odd e⁻ can participate in hybridisation only when surrounding atom is high EN.

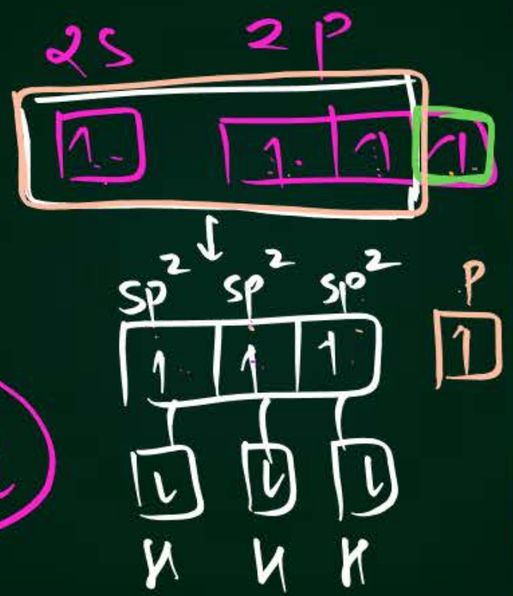
Ex. CH_3

sp^3 ~~sp^3~~

sp^2

T. planar

~~Tetra~~



Q In CH_3 odd e⁻ present in

(1) sp^3 H.O.

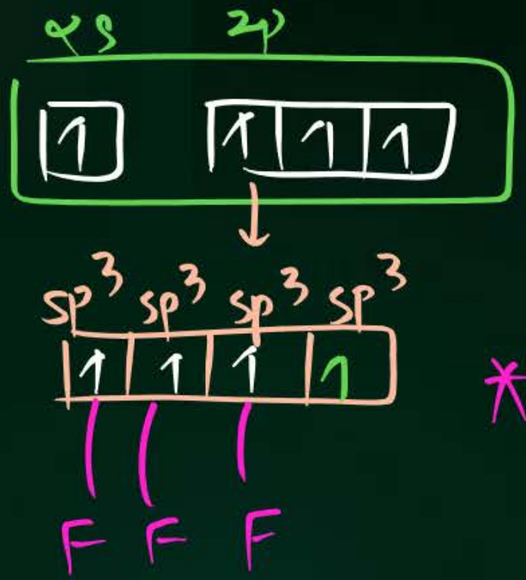
(2) sp H.O.

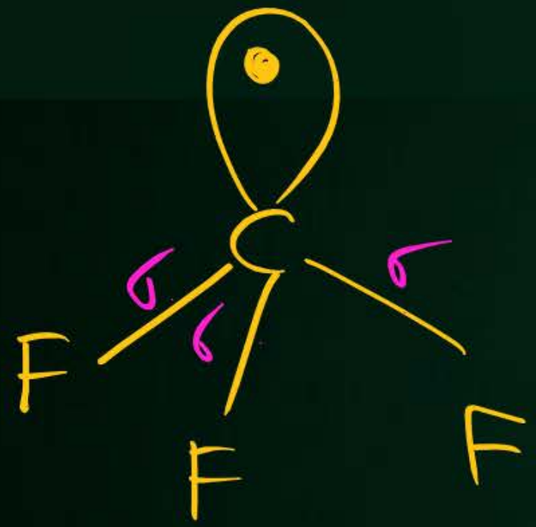
(3) sp^2 H.O.

(4) Pure "p" orbital.

S.A ⇒ F High EN

Ex.2 CF_3



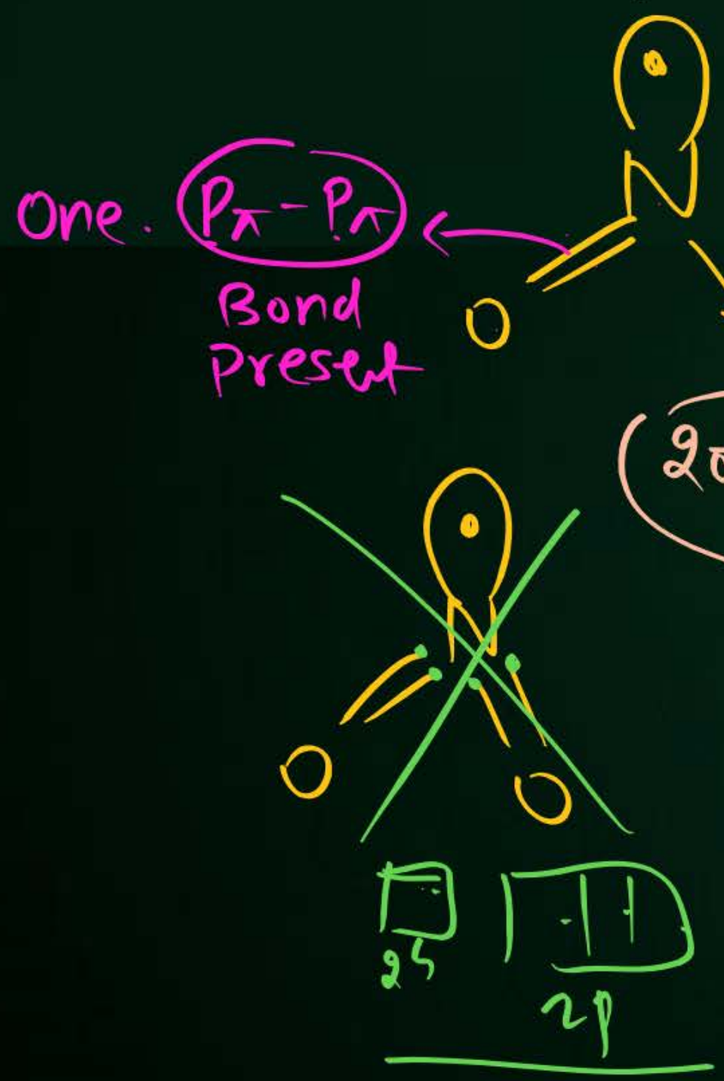


Trigonal pyramidal

$3\sigma + 1$ odd e^- orbital $= (4) \rightarrow sp^3$

* Odd e^- in CF_3 is present in sp^3 Hybrid orbital.

Ex. 3 NO_2



$2\sigma + 1$ odd $\bar{e}$ $\rightarrow$ sp^2, Bent.

– 1σ Coordinate present

– Acidi oxide $\rightarrow$ Can Cause Acid Rain

$\overset{+4}{N}O_2 + H_2O \rightarrow \overset{+2}{N}O + H\overset{+5}{N}O_3$

$O-\hat{N}-O$ Bond Angle in NO_2

$\theta = 134^\circ$.

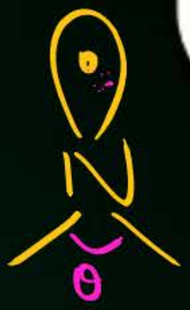
Bond Angle order :-

$NO_2^+ > NO_2 > NO_3^- > NO_2^-$

$180^\circ \quad 134^\circ \quad 120^\circ \quad \theta < 120^\circ$

$\theta = 120^\circ$

$\theta < 120^\circ$



$120 < \theta < 180$

$\simeq 134^\circ$.

Hybridisation of some molecules in solid state

Imp

$PCl_5(s) \longrightarrow PCl_4^+ + PCl_6^-$

$PBr_5(s) \longrightarrow PBr_4^+ + Br^-$

$N_2O_4(s) \longrightarrow NO^+ + NO_3^-$

$N_2O_5(s) \longrightarrow NO_2^+ + NO_3^-$

$XeF_6(s) \longrightarrow XeF_5^+ + F^-$

NOT in NCERT

$PCl_{5(s)} \longrightarrow \underbrace{PCl_4^+}_{\text{Cation}} + \underbrace{PCl_6^-}_{\text{Anion}}$ (Bond: Ionic)

Cation: AB_4L_0, Tetra, sp^3

Anion: AB_6L_0, Octa, sp^3d^2

Existing & Non-Existing molecules

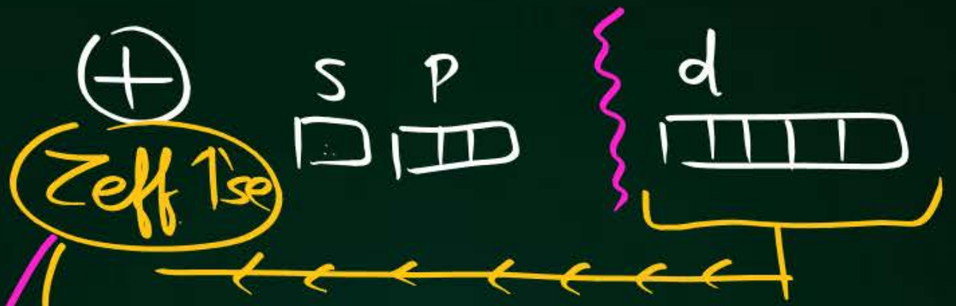
Improper Covalency ✓
Steric hindrance ✓
non contracted d orbitals
Non existance

(A) Non-contraction of d-orbitals

Existing		Non-Existing	
XeF_6	sp^3d^3	XeH_6	X sp^3d^3
XeF_2	sp^3d	XeH_2	sp^3d
SF_6	sp^3d^2	SH_6	sp^3d^2

then

If central atom have to use its d-orbitals in hybridisation, they must be sufficiently contracted it is only possible when surrounding atom in high EN.



Contraction 1se

Energy gap ↓se

easy mixing of d orbital

when

S.A high EN

+δ

C.A → +s ↑

Zeff ↑

∴ S.A EN ↑

Existing & Non-Existing molecules

Max Covalency of 2nd period is → 4

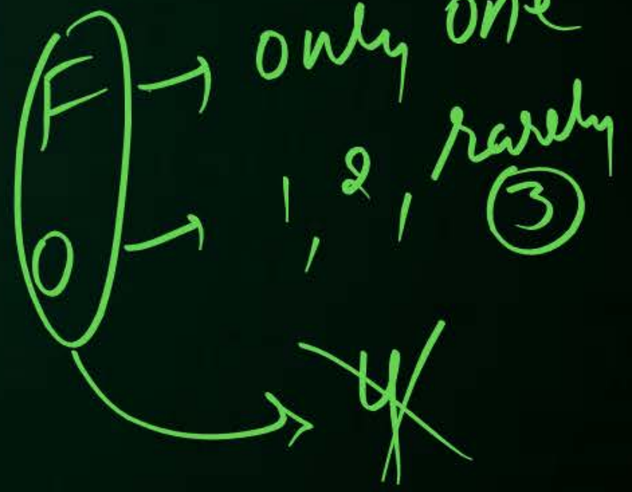
(B) Improper covalency

Existing

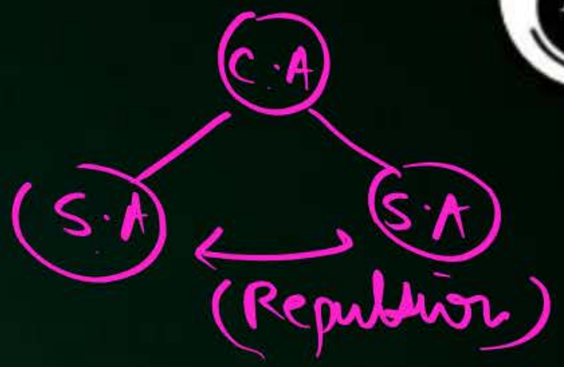
- NCl_3
- BF_4^-
- ClF_3

Non-Existing

- NCl_5
- BF_6^{3-}
- FCl_3



Existing & Non-Existing molecules



(C) Steric Hindrance

Existing

- PCl_6^-
- SiF_6^{2-}
- IF_7

Non-Existing

- PBr_6^- (Br size large)
- $SiCl_6^{2-}$
- ICl_7

IBr_7

Some Imp Point :-

MDJ 1 ⇒ Multiple Bond & l.p Bhai-Bhai

(=/≡) (🙂)

that means Multiple bonds occupy - positions in structure Same as l.p

① In T-B-P geometry

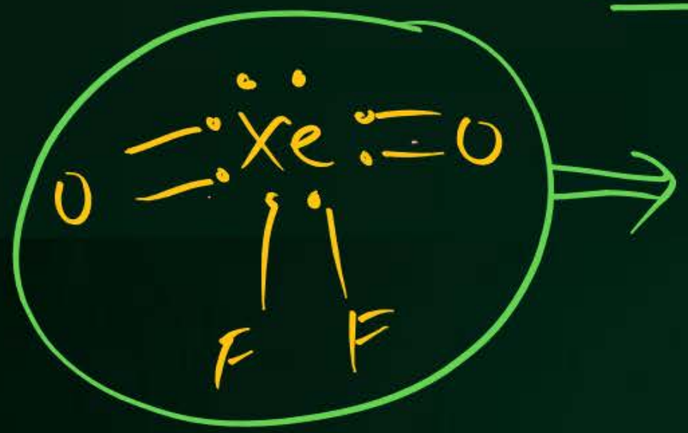
l.p → equatorial

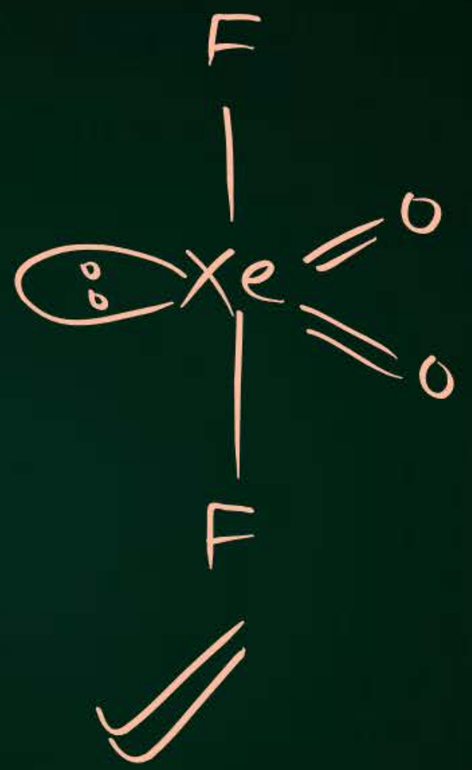
Multiple Bond → equatorial.

Ex XeO_2F_2

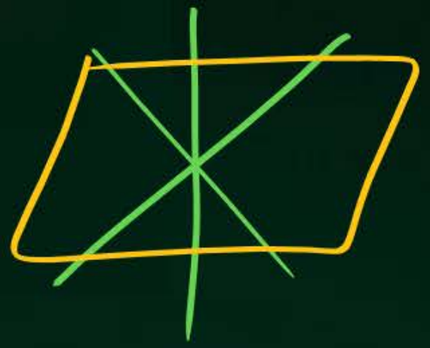
AB_4L_1

seesaw





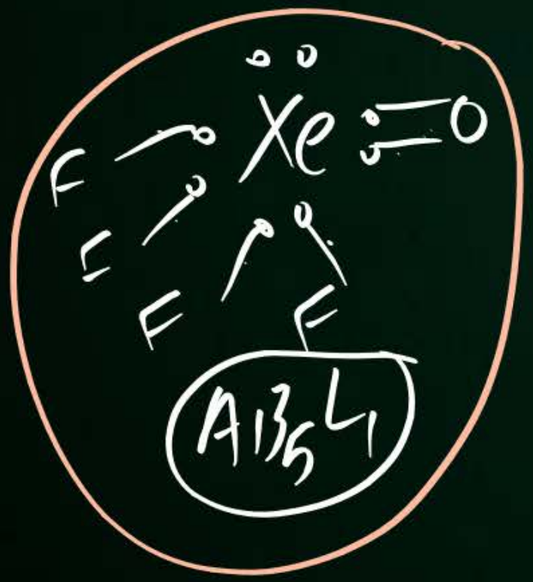
(2) In S.B.P / octahedral parent geometry



1st l.p / Multiple Bond
↓
at Any Position

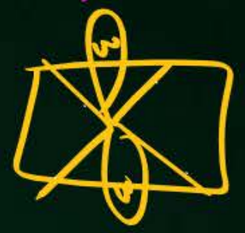
2nd l.p / Multiple Bond
↓
opposite to each other

(Ex) $XeOF_4$



⇒ geometry in which Zero effect of l.p on Bond Angle

Sq. planar. AB_4L_2



$\theta = 90°$

linear AB_2L_3

$\theta = 180°$

Pentagonal Planar - AB_5L_2

$\theta = 72°$

QUESTION

Molecule which does not contain any F–X–F bond angle which is less than 90° ? (X = central atom)

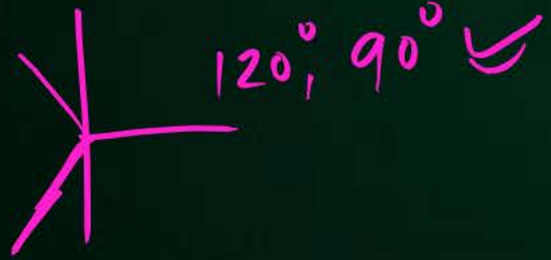
1. IF_7 AB_7L_0

$\theta = 72°$

2. BrF_3 AB_3L_2 Bent T

$\theta < 90°$

3. PF_5



120°, 90°

$\theta < 90°$

4. SF_4 AB_4L_1 See saw

QUESTION

These is not effect of lone pair on bond angle in :

1. XeF_2, ICl_4^-

2. BF_3, OF_2

3. IF_5, NH_3

4. I_3^-, I_3^+

QUESTION

The bond angle around central atom in highest in :

1. BBr_3 AB_3L_0 T-planar 120°
2. CS_2 AB_2L_0 linear 180°
3. SO_2 AB_2L_1 Bent $\theta < 120^\circ$
4. SF_4 AB_4L_1

QUESTION

Set of planar species having same hybridization and same bond angle :

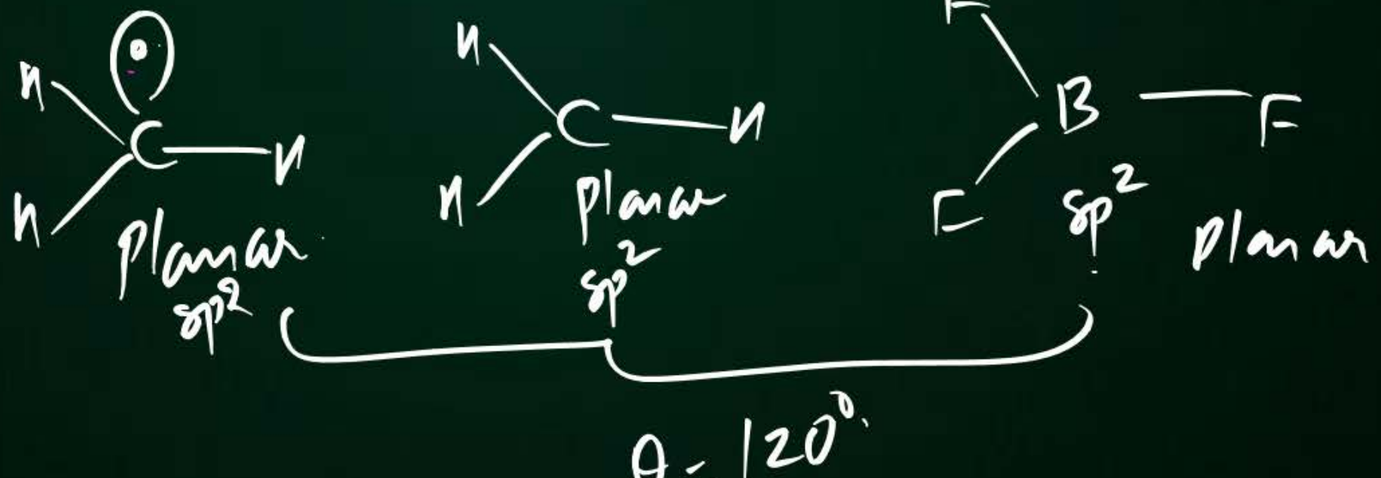
AB_4L_0 tetra

1. CH_4, BF_3, NH_3

2. CH_4, BF_4^-, NH_4^+

3. $\dot{C}H_3$, $\overset{+}{C}H_3$, BF_3

4. $\dot{C}F_3$, $\overset{+}{C}F_3$, SO_3



QUESTION

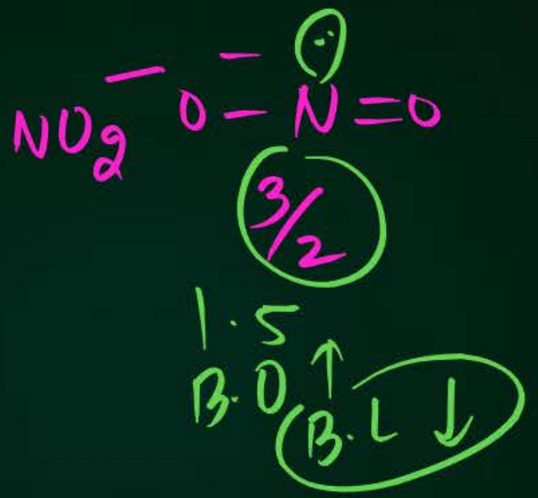
Which of the following order is not correct ?

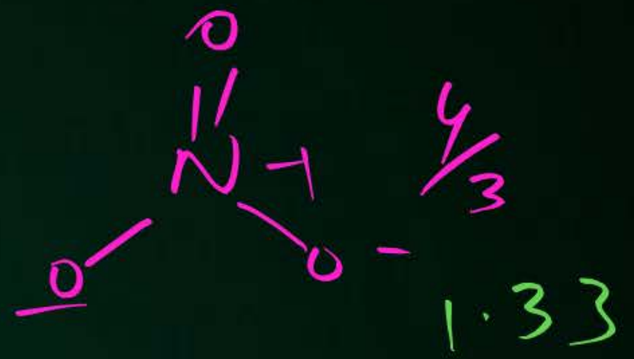
1. NO_2^- > NO_3^- bond order

2. NO_2^- > NO_3^- bond angle

3. NO_2^- > NO_3^- formal charge on terminal oxygen

4. NO_2^- > NO_3^- bond length





QUESTION

PCl_4^+ , PCl_6^-

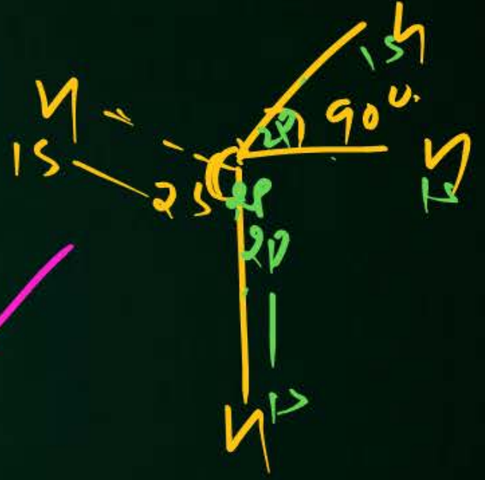
$PCl_5(s)$ contain following species :

1. Trigonal bipyramidal only
2. Square pyramidal & tetrahedral
3. Tetrahedral & octahedral
4. Tetrahedral & pyramidal

QUESTION

CH_4 without Hybridisation

Assuming pure 2s and 2p orbitals of carbon are used in forming CH_4 molecule, which of the following statement is false ?

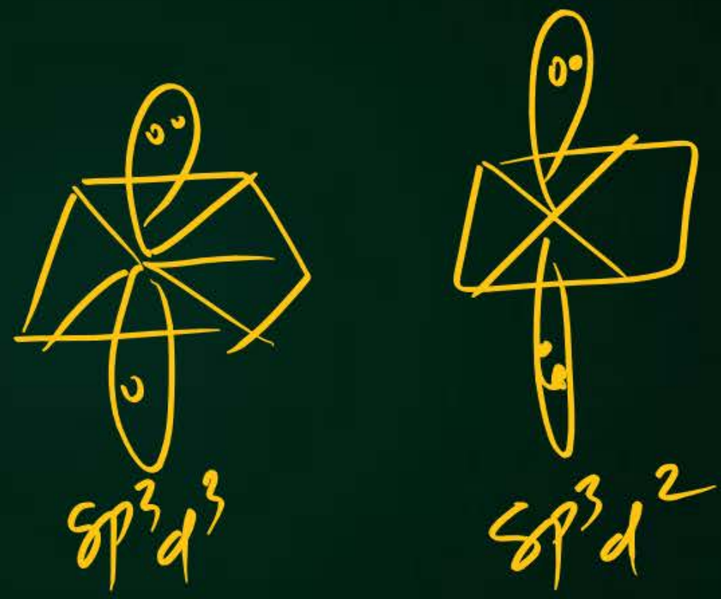


1. Three C–H bonds will be at right angle ✓
2. One C–H bond will be weaker than other three C–H bonds ✓
3. The shape of molecule will be tetrahedral ✗
4. The angle of C–H formed by s-s overlapping will be uncertain with respect to other three bonds. ✓

QUESTION

In which of the following hybridisation, lone pairs are observed on opposite position ?

1. sp^3d
2. sp^3d^2
3. sp^3d^3
4. Both (2) and (3)



Homework

From Module - 1

Questions Based on
- Shape
- Hybridisation
- Bond Angle
- overlapping

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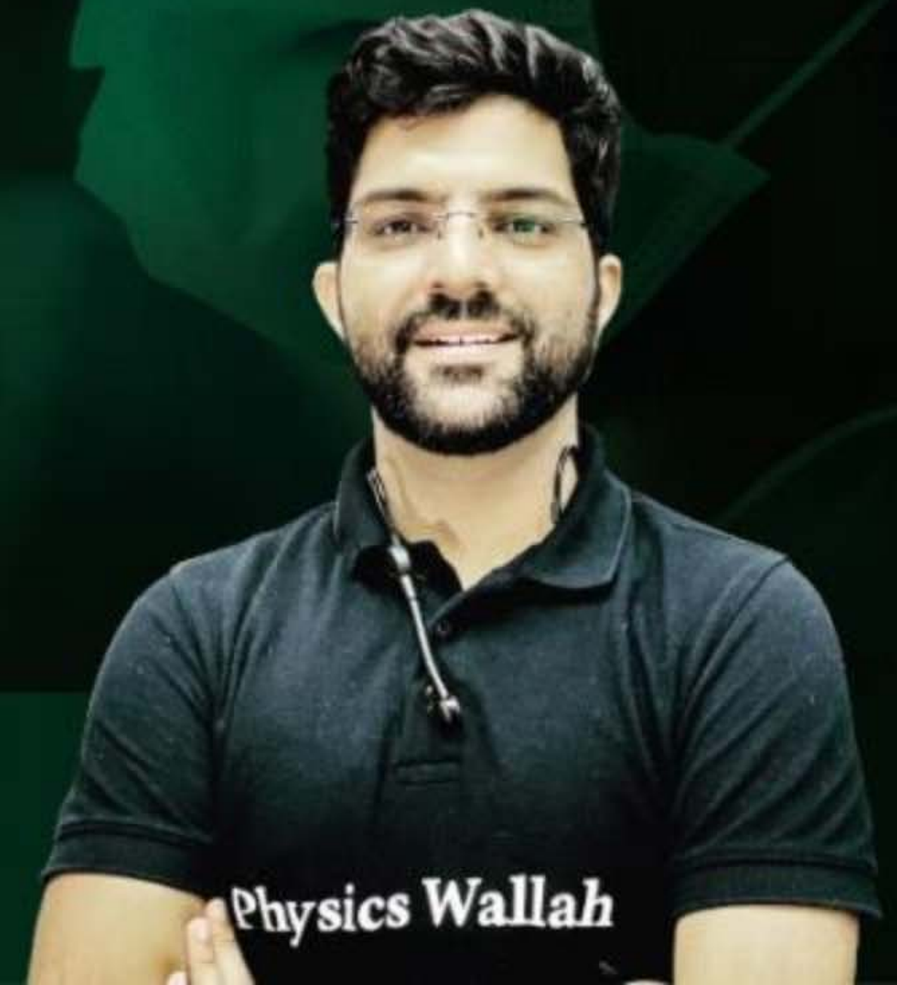
Lecture - 10 | Inorganic Chemistry

Chemical Bonding & Molecular Structure

By - Mohit Dadheech (MD Sir)



Topics *to be covered*

1. Dipole Moment

H.W

Lec-6

Ans

		d-orbitals used.	d orbitals remains Pure.
XeF_4	AB_4L_2 sp^3d^2	$d_{z^2}, d_{x^2-y^2}$	d_{xy}, d_{yz}, d_{xz}
IF_7	AB_7L_0 sp^3d^3	$d_{z^2}, d_{x^2-y^2}, d_{xy}$	d_{yz}, d_{xz}
ICl_2^-	AB_2L_3 sp^3d	d_{z^2}	$d_{x^2-y^2}, d_{xy}, d_{yz}, d_{xz}$
XeF_2	AB_2L_3 sp^3d	—	— 4 — —
ClF_3	AB_3L_2 sp^3d	—	— — 4 — —

27. Which of the following order is not correct ?

(A) $NO_2^- > NO_3^-$ bond order ✓

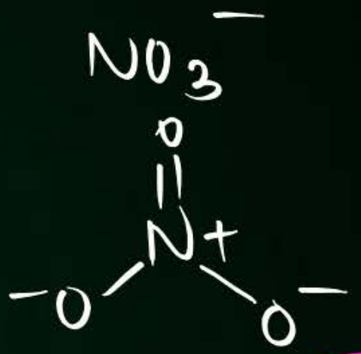
(B) $NO_2^- < NO_3^-$ bond angle ✓

(C) $NO_2^- < NO_3^-$ formal charge on terminal oxygen ✓

(D) $NO_2^- > NO_3^-$ bond length ✗

$\theta < 120$

$\theta = 120°$



Avg Bond order. $\frac{3}{2} = 1.5$

$\frac{4}{3} = 1.33$

Bond length. $NO_2^- < NO_3^-$

Avg F.C $-\frac{1}{2} = -0.5$

$-\frac{2}{3} = -0.66$

Correct order of Bond lengths :—

B—F < B—Cl

(1) BF_4^- < BF_3 X

sp^3 sp^2

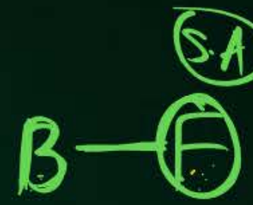
(2) NO_2^+ < NO_2^-

sp sp^2

(3) CCl_4 < CF_4 X C—Cl > C—F

(4) $\overset{+}{C}H_3$ > CH_4 X

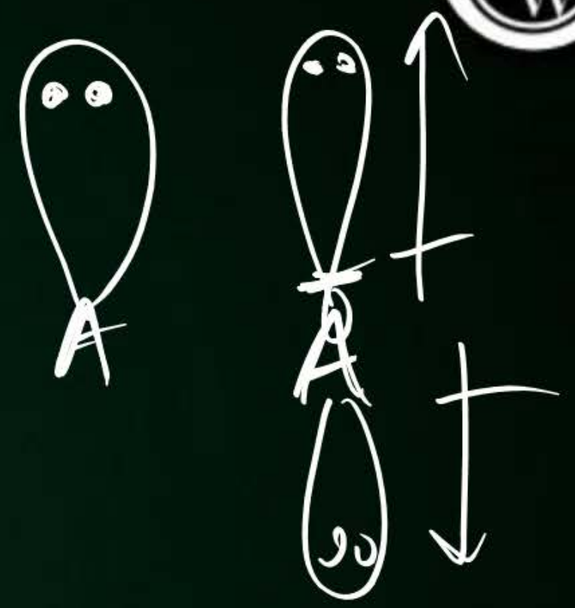
sp^2 sp^3



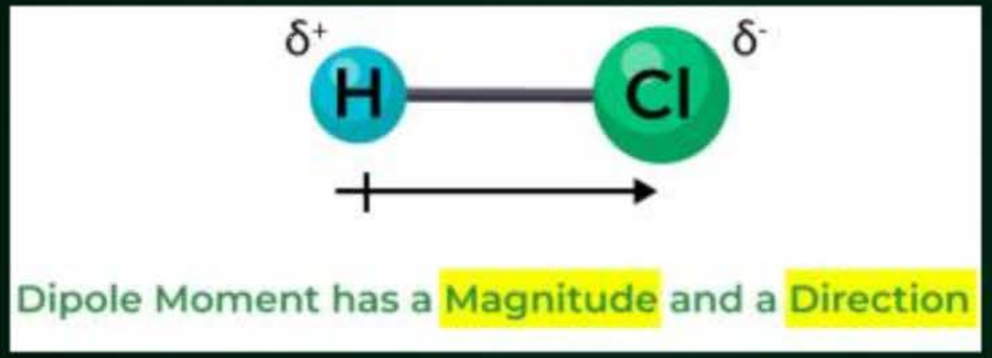
$sp < sp^2 < sp^3$ (B.O / bond length)

Dipole Moment (μ) :

$\mu = 0$ Non polar
$\mu \neq 0$ polar



* Dipole moment is a measure of the net polarity of a molecule.



Dipole Moment has a Magnitude and a Direction

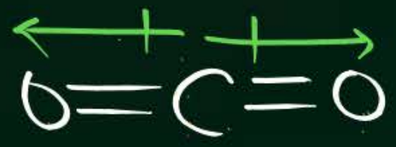
* It is a vector quantity & directed towards more EN element
* Dipole moment of lonepair is always away From the Molecule

Ex

Bond polarity
↓
By ΔEN

Molecule Polarity
by (Net)
Dipole moment

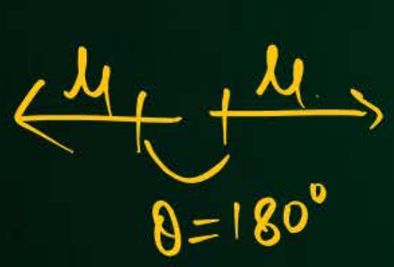
Ex CO_2 AB_2L_0



Polar Bonds present ✓

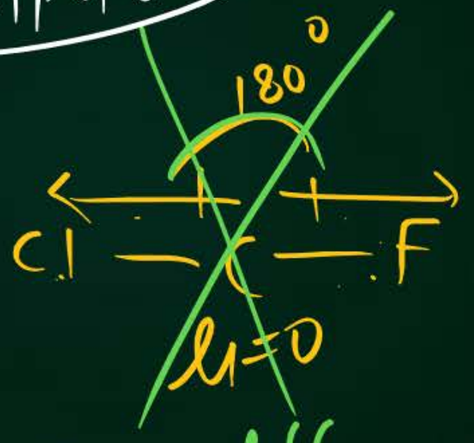
~~Molecule Polar~~

Nonpolar



$\mu_R = 0$

Non polar

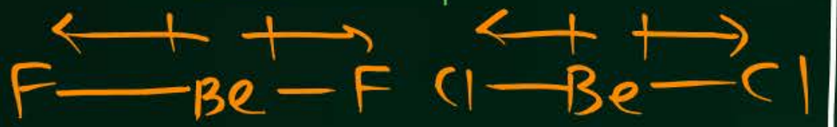


∴ Vectors diff

Ex.2

BeF_2 | $BeCl_2$

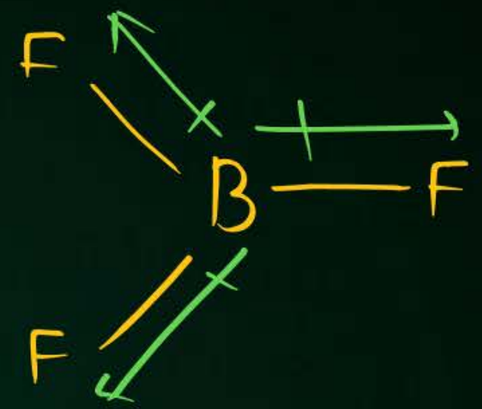
AB_2L_0 | AB_2L_0.

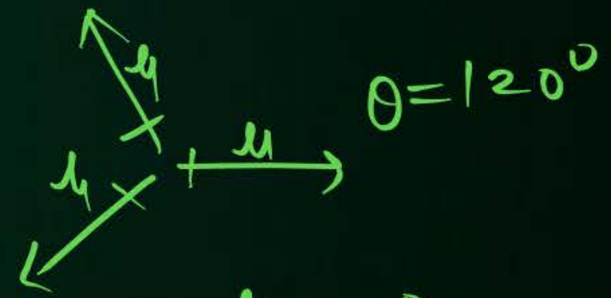


$\mu = 0$ | $\mu = 0$

Non polar.

Ex.3 BF_3 AB_3L_0.





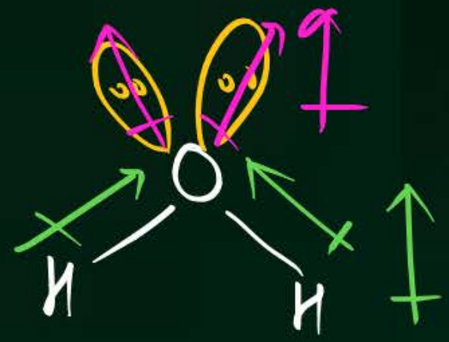
$\mu_R = 0$

Non polar.

Ex. 4

H_2O

AB_2L_2



$\mu \neq 0$

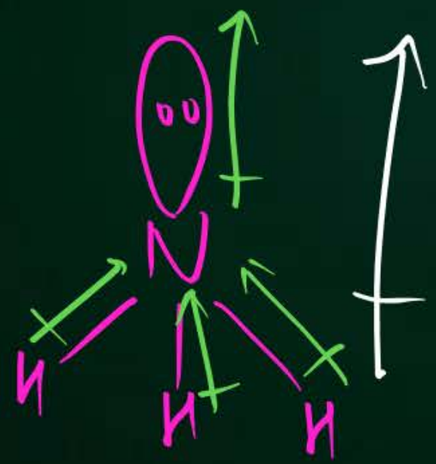
$\mu \neq 0$

Polar ✓

Ex. 5

NH_3

AB_3L_1



$\mu \neq 0$

Polar Molecule

Dipole Moment (μ) :

$\Delta EN \uparrow \quad q \uparrow$

$$\mu = q \times d$$

'q' is magnitude of charge
'd' is internuclear in distance
(Bond length)

1 Debye = 3.3×10^{-30} cb × m

⇒ For symmetrical structures μ is always zero.

NOTE : Vectors must be same.

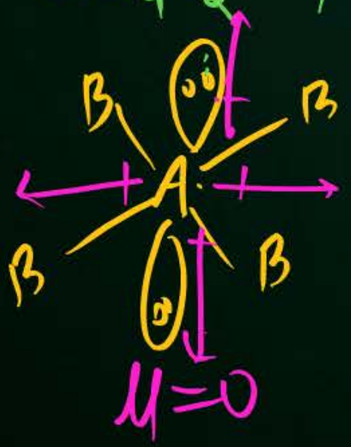
All the Terminal atoms Must be same

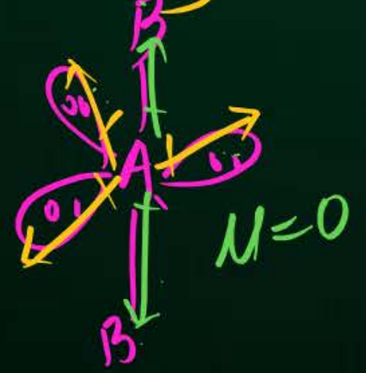
Symmetrical

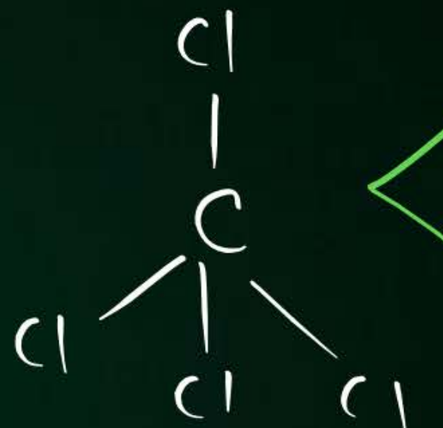
① AB_2L_0 to AB_7L_0

② AB_4L_2 , AB_3L_3

} $\mu = 0$ Non polar





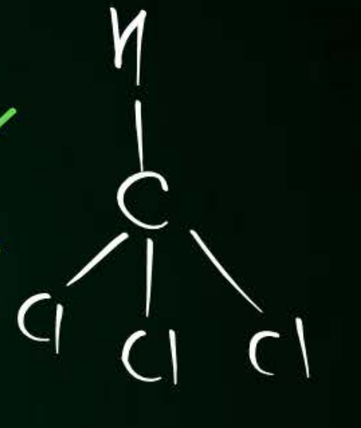


CCl_4

AB_4L_0

$\mu = 0$

Nonpolar solvent.



$CHCl_3$

AB_4L_0

$\mu \neq 0$

∵ Vectors are diff.-

Comparison

(A) (B)

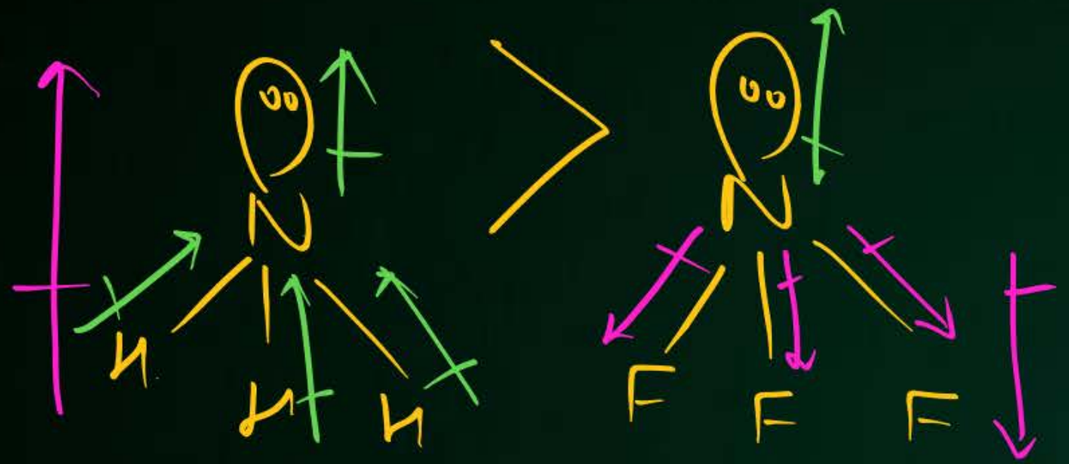
$\mu = 0 = \mu = 0$ ✓

$\mu \neq 0 > \mu = 0$ ✓

$\mu \neq 0 = \mu \neq 0$ ✗

Compare Dipole Moment in following :

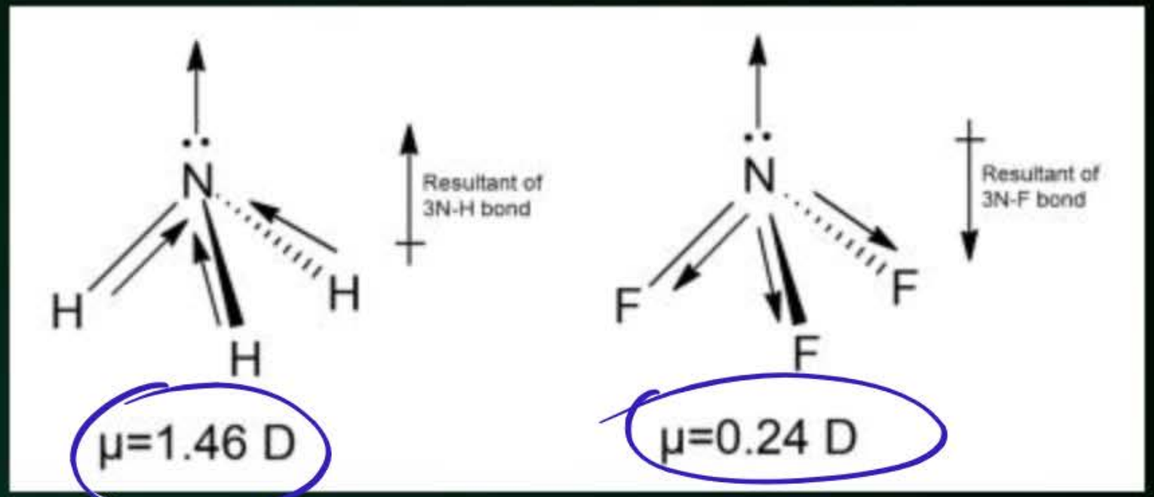
(i) NH_3 > NF_3



$\mu \neq 0$ $\mu \neq 0$

Both Bond dipole and l.p dipole (atomic dipole) are in same direction (μ ↑se)

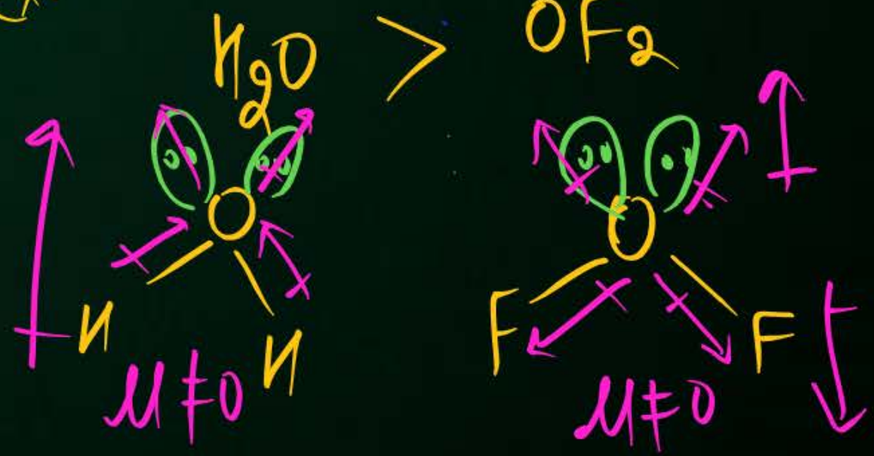
$(NH_3 > NF_3)$



Similar Ex.

Reason

Same as NH_3



(ii) XeO_3 AB_3L_1 $\mu \neq 0$ > XeO_4 AB_4L_0 $\mu = 0$

(iii) $CHCl_3$ AB_4L_0 $\mu \neq 0$ > CCl_4 AB_4L_0 $\mu = 0$

Vec diff

(iv) PCl_3 AB_3L_1 $\mu \neq 0$ > PCl_5 AB_5L_0 $\mu = 0$

(v) SF_4 AB_4L_1 $\mu \neq 0$ > $SiCl_4$ AB_4L_0 $\mu = 0$

(6) SO_2 AB_2L_1 $\mu \neq 0$ > CO_2 AB_2L_0 $\mu = 0$

(7) SO_2 AB_2L_1 $\mu \neq 0$ > SO_3 AB_3L_0 $\mu = 0$

(8) XeF_2 AB_2L_3 $\mu = 0$ = XeF_4 AB_4L_2 $\mu = 0$

(9) SF_4 AB_4L_1 $\mu \neq 0$ > SF_6 AB_6L_0 $\mu = 0$

(10) CO_2 AB_2L_0 $\mu = 0$ < O_3 AB_2L_1 $\mu \neq 0$

(11) $BeCl_2$ < H_2O

(12) $NCl_3 > BCl_3$

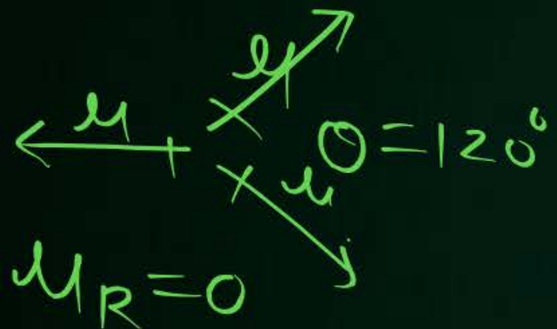
(13) $BF_3 = BCl_3$

(i) $u \leftarrow \quad + \quad \rightarrow u$

$\theta = 180$

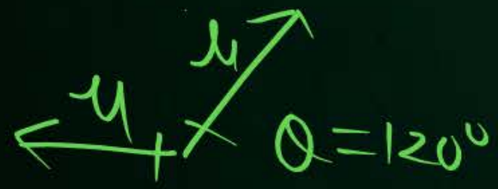
$u_R = 0$

(ii)



$u_R = 0$

(iii)



$u_R = u$

$$u_R = \sqrt{u_1^2 + u_2^2 + 2u_1u_2\cos\theta}$$

$\cos\theta$	0°	60°	120°	180°
	1	$\frac{1}{2}$	$-\frac{1}{2}$	-1

$\theta \uparrow \quad u_R \downarrow$

Ex ①

Benzene

$\mu = 0$

Nonpolar

(2)

$\mu \neq 0$

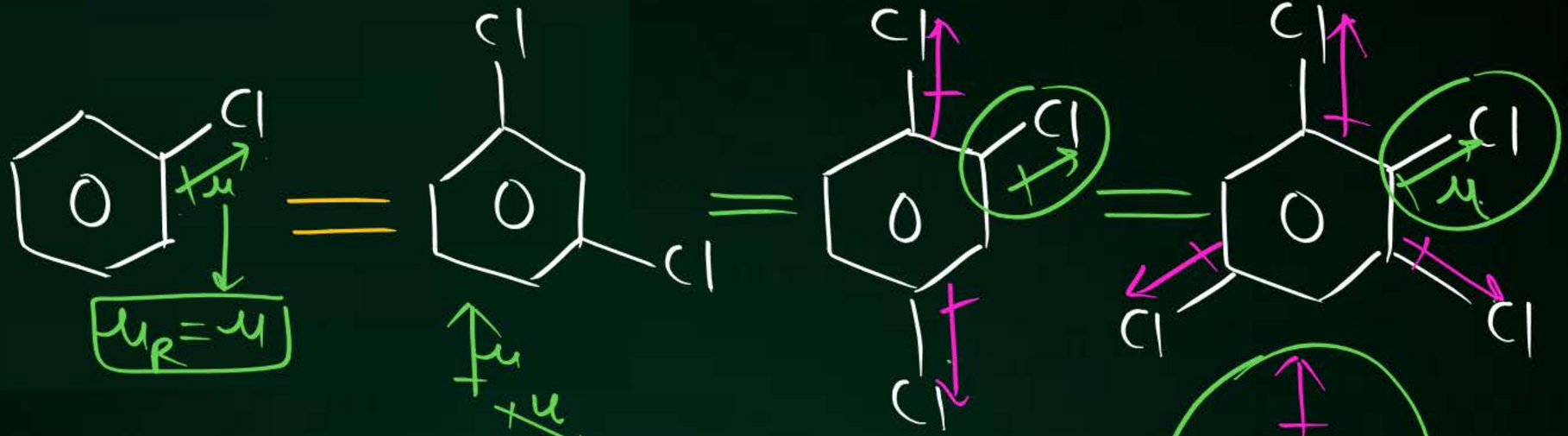
Polar

③

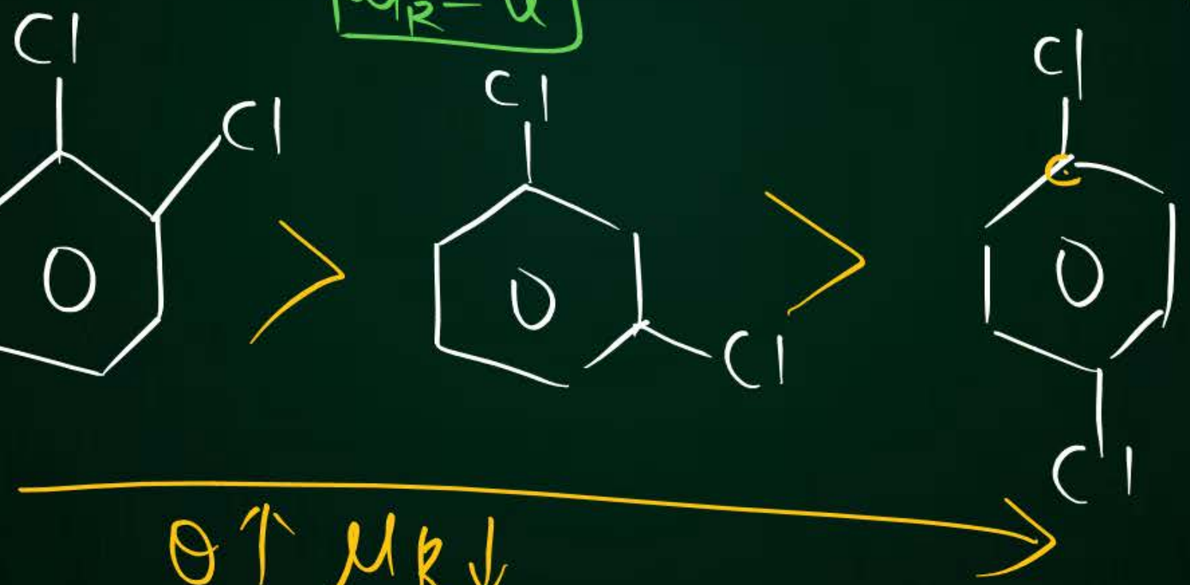
$\mu = 0$

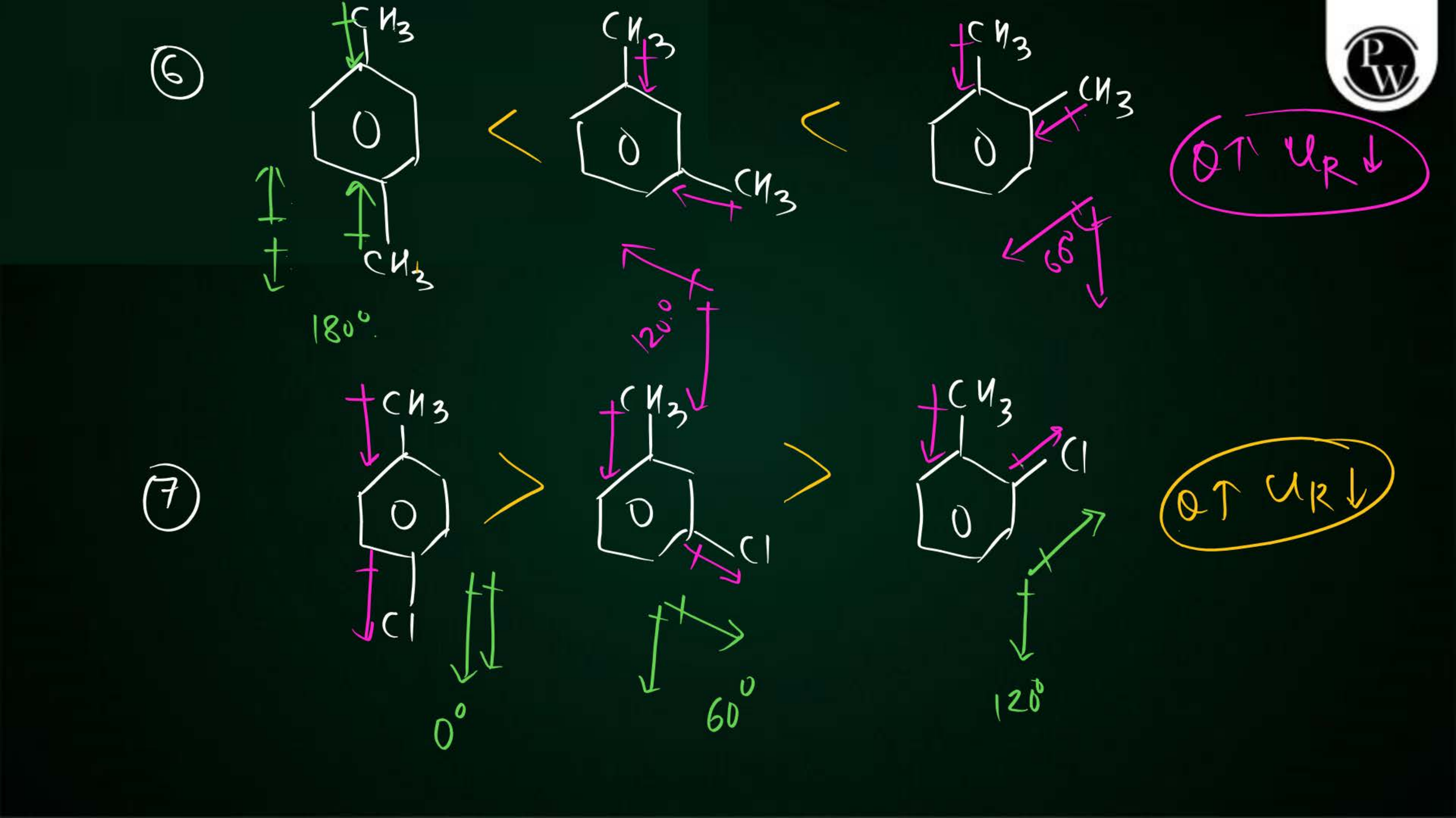
Nonpolar

(4)

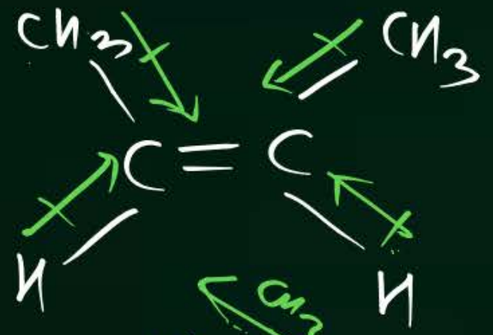


(5)



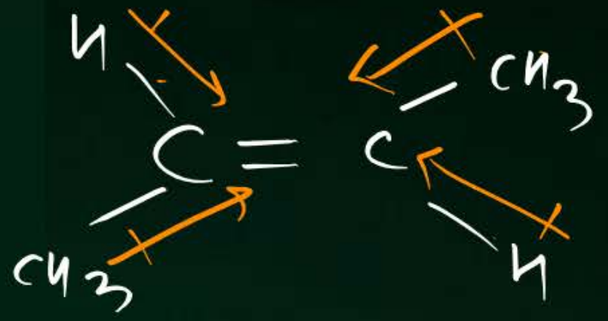

6
CH3
O
CH3
CH3
180°
<
CH3
O
CH3
<
CH3
O
CH3
120°
60°
θ↑ μR↓
7
CH3
O
Cl
0°
>
CH3
O
Cl
60°
>
CH3
O
Cl
120°
θ↑ μR↓

(8)



Cis Butene

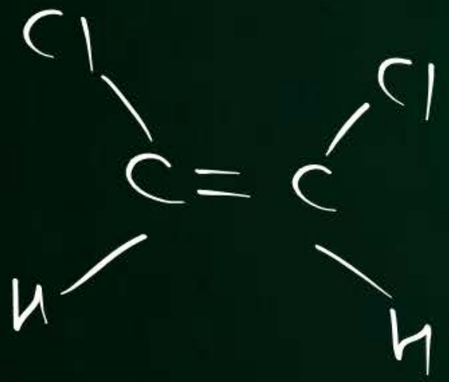
$\mu \neq 0$

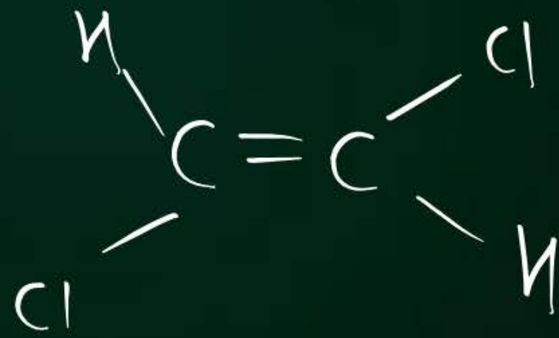


Trans - Butene

$\mu = 0$

(9)





H.W

Examples based on q

Imp

$\Delta EN \uparrow \; q \uparrow \; \mu \uparrow$

$\mu = q \times d$

(i) HF > HCl > HBr > HI

(ii) HF > NH_3 > PH_3

H – F N – H P – H

(iii) H_2O > NH_3 > PH_3

O → H N – H P – H

(iv) H_2O > H_2S

Some special example (Data based) :

(i) CH_3F (2) CH_3Cl (1) CH_3Br (3) CH_3I (4)

1 > 2 > 3 > 4

(ii) CH_3Cl (1) CH_2Cl_2 (2) $CHCl_3$ (3) CCl_4 (4)

(iii) H_2O > HF (Acc. to NCERT)

Cl > F > Br > I

E.A

Homework

Module - 1

questions Based on

dipole moment

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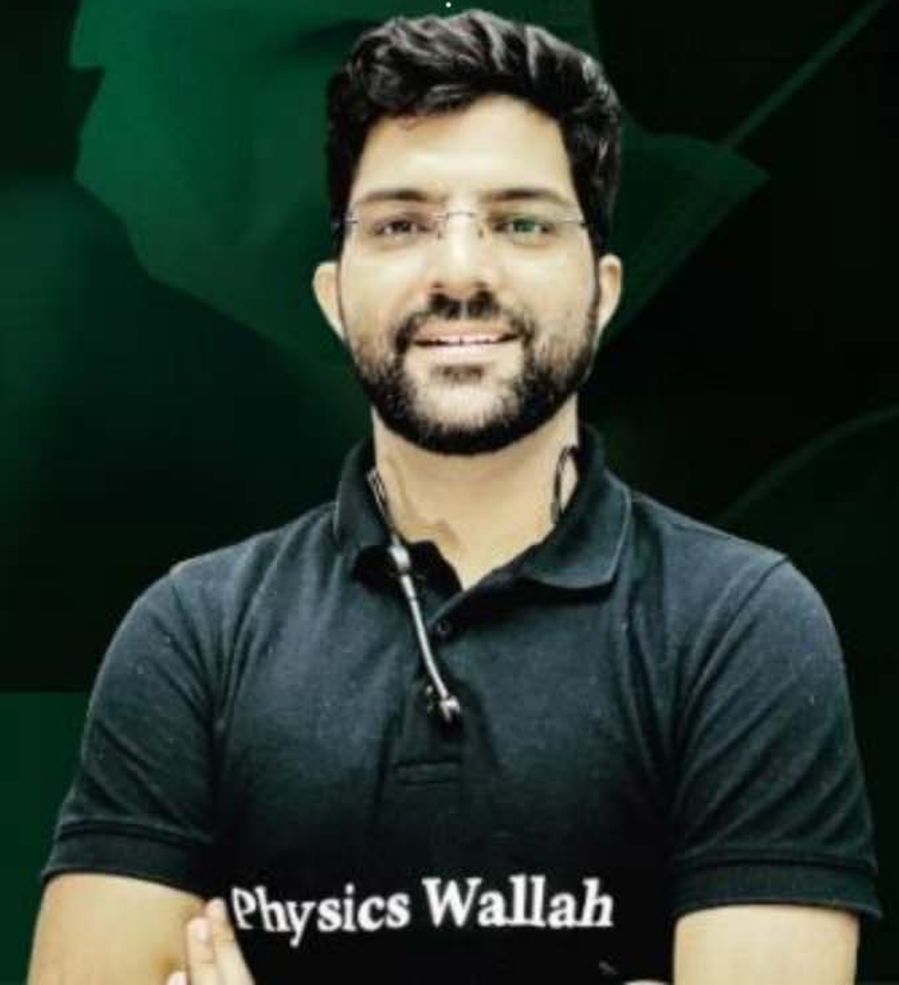
FOR NEET 2025

Lecture - 11 | Inorganic Chemistry

Chemical Bonding & Molecular Structure



By - Mohit Dadheech (MD Sir)

Topics *to be covered*

1. Ionic Bond/Electrovalent Bond

Lec.7 (H.W) Ans Bond strength order:

$C-C > Si-Si > Ge-Ge > Sn-Sn$

$C-C < C=C < C\equiv C$

$N-N < N=N < N\equiv N$

$C=N < C\equiv N$

$C=O < C\equiv O$

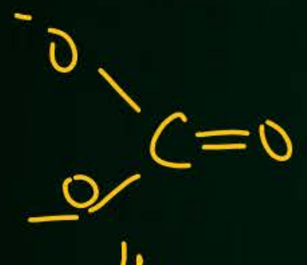
$O-O < O=O$

$H-F > HCl > HBr > HI$

$CO_3^{2-} > CO_2 > CO$ (C–O Bond length)

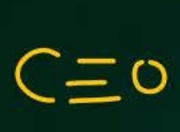
B.O $\propto \frac{1}{\text{B.L}}$

$O_2 < O_3 < H_2O_2$ (O–O Bond length)



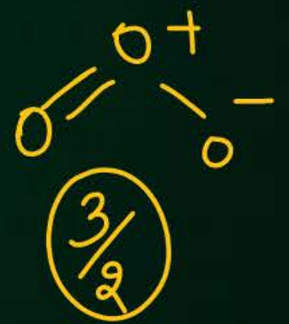
B.O $\frac{4}{3}$ (1.33)

2

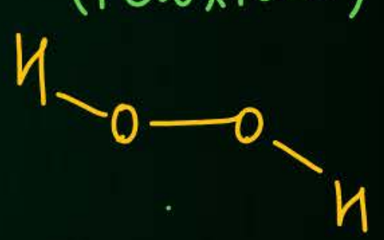


3

2



$\frac{3}{2}$ = 1.5



1

Q $XeO_3F_2 \Rightarrow$ Bond pairs ($\sigma+\pi$), bondpairs (π), l.p at Xe respectively.

(1) 5, 2, 0

(2) 4, 2, 2

(3) 8, 3, 0 ✓

(4) 4, 4, 0

AB_5L_0

$\frac{8+18+14}{8} \quad \frac{40}{8} = 5$ Q

R = 0

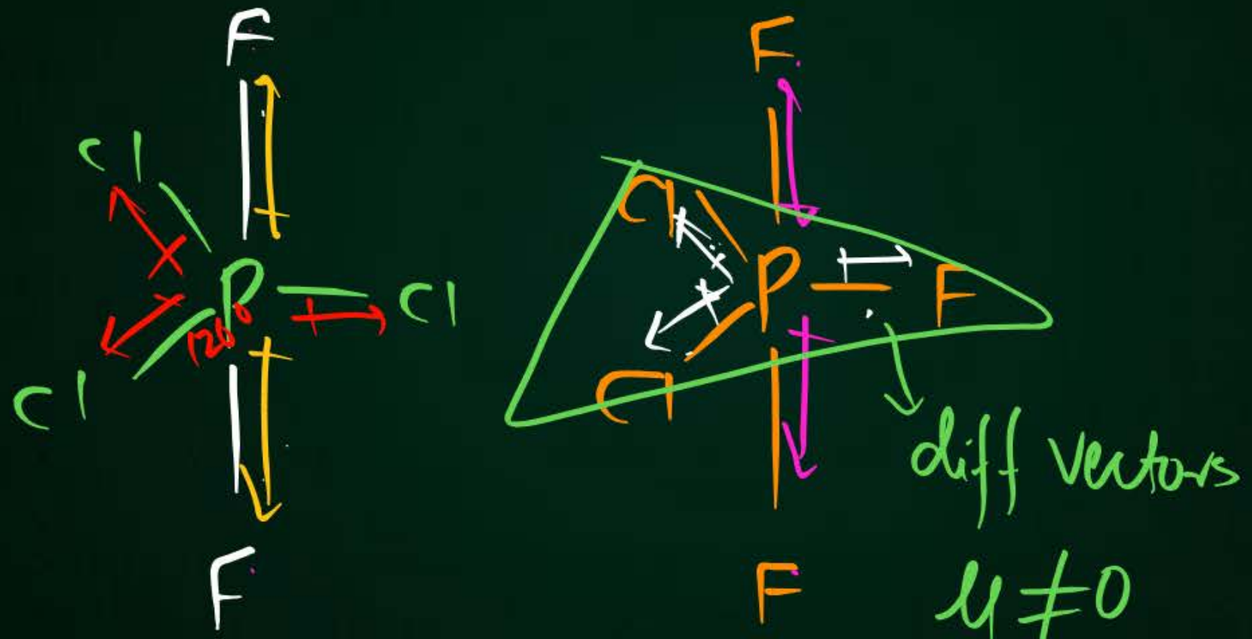
AB_mL_n

B_m: σ Bond Pair

L_n: no. of l.p at c.A

Dipole Moment Special Examples

Ex.1 PCl_3F_2 < PCl_2F_3



$\mu = 0$

Nonpolar

diff vectors

$\mu \neq 0$

Polar

Ex-2

$\mu = 0$

N·P

$\mu = 0$

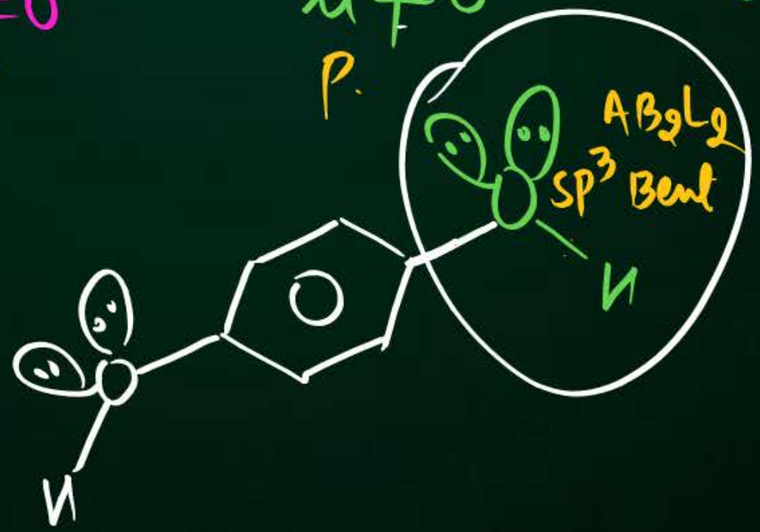
N·P

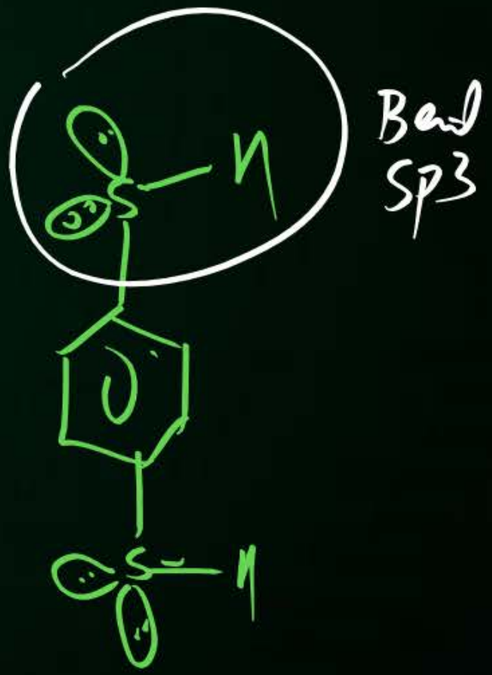
$\mu \neq 0$

P.

$\mu \neq 0$

P.





Ionic Bond / Electrovalent Bond :

Valency → Na^+ Cl^-

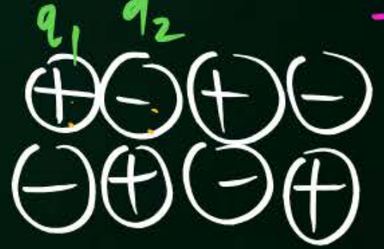
- Bond formed by complete transfer of electron.
- Electrostatics force / coulombic force of attraction b/w oppositely charged ions.

$$F = \frac{K q_1 q_2}{r^2}$$

- Generally formed b/w metals and non-metals.

Metals → Electropositive → Cation → Having Low I.E

Non-metals → Electronegative → Anion → High ΔHeg

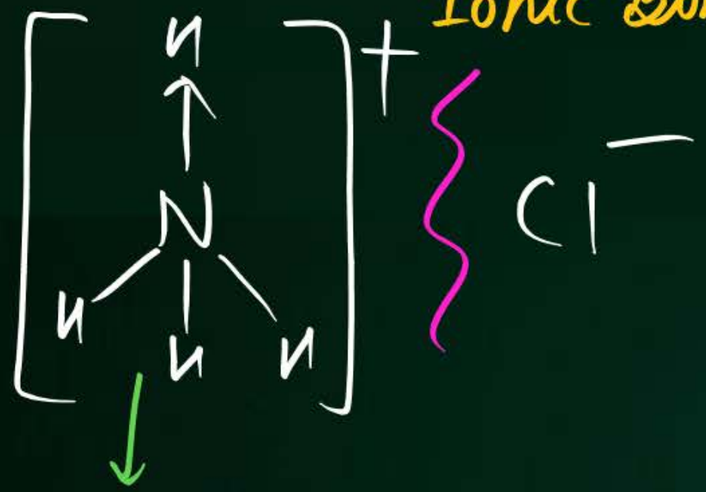


3D Crystal Lattice.

Ex NH_4Cl

Metal ~~Present~~

Ionic Bond ✓✓



- Simple covalent
- Coordinate

NH_4Cl

- Coordinate ✓
- Simple covalent ✓
- Ionic ✓

Ex. $CsBr_3$

Ionic Bond.

$Cs^{+} \} Br_3^{-}$

Br^{-}

O.S of Cs ~~+3~~

Never

Alkali metal always show +1 O.S

Ex.

$Tl^{+1} \} I_3^{-}$

$TlI_3 \rightarrow$ ~~Tl^{+3}~~

~~I^{-}~~

- Ionic compounds are generally solid, brittle in nature at room temperature.

∵ due to strong electrostatic Force of attraction.

- Ionic compound do not show isomerism.

Reason :- due to absence of directional Bonds.

- Ionic compound are polar and readily soluble in polar solvent like water.

isomerism (Molecular Formula same)

↓

directional property

required directional Bonds

Cov. Compounds

Ionic Bond → Non directional

Covalent → Directional Bond.

$+\delta \quad -\delta$

$A - B$ Polar Bond

Covalent Bond → ΔEN present → Ionic ch↑ ✓

Polarity ↑

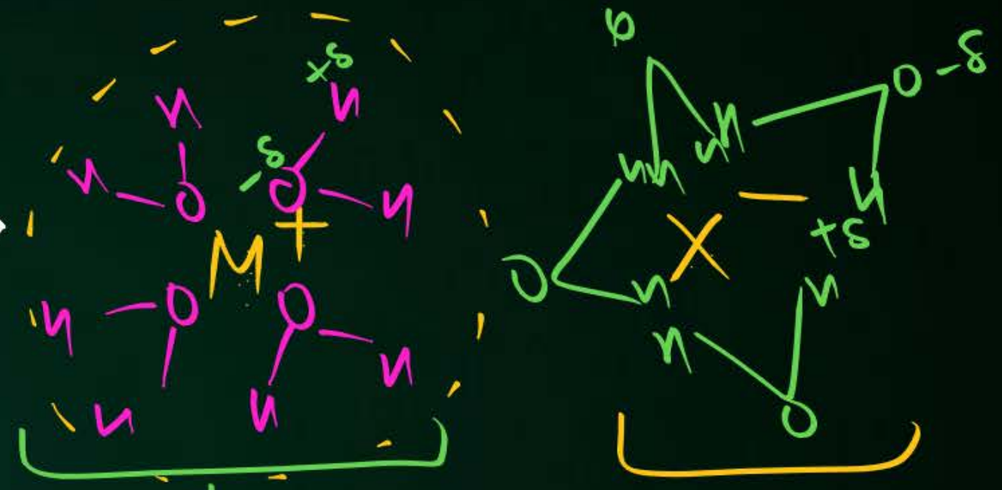
$A^{+\delta} B^{-}$

Ionic → Polar →

Polar compounds dissolve in polar solvent like water

Ionic Compound + Water → Hydration

$M^+X^- + nH_2O \longrightarrow$



Hydrated Cation

Hydrated anion.

Hydration

Bonding

B/w ions & water Molecule

∴ Exothermic Process

Energy Release. (Hydration Energy)

degree of Hydration ↑se ⟶ Hydration Energy ↑se
(More Exothermic)

Some imp orders

$Li^+ < Na^+ < K^+ < Rb^+ < Cs^+$ (Size (Normal))

$Li^+ > Na^+ > K^+ > Rb^+ > Cs^+$ (degree of Hydration)

$Li^+ > Na^+ > K^+ > Rb^+ > Cs^+$ (Size of Hydrated ion)

$Li^+ < Na^+ < K^+ < Rb^+ < Cs^+$ (Ionic Mobility or Conductance)

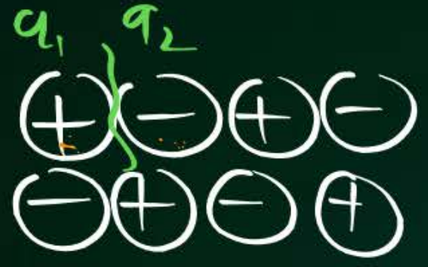
(ϕ ⇒ Polarising Power of Cation)

$$\phi \propto \frac{\text{charge}}{\text{radius}}$$

$$\phi \propto \frac{q^+}{r^+}$$

- Ionic compounds have high M.P & B.P. as Compare to Covalent Compounds

Ionic Compounds



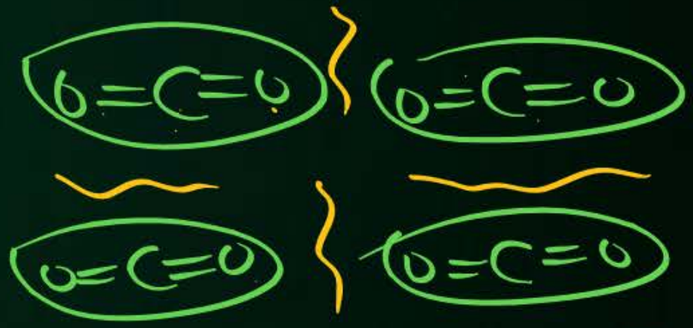
$$F = \frac{K q_1 q_2}{r^2}$$

Strong electrostatic Force of attraction b/w q_1 & q_2

∴ High M.P & B.P

(Existin Molecules) (Molecular Solid)

$CO_2(s)$



Weak Vanderwaal Force b/w CO_2 Molecules

Electrical conductivity :

Ionic Compounds	Solid	aq.	liquid (Molten)
Presence of ions	✓	✓ In Form of Hydrated ion	✓
Mobility of Ions	✗	✓	✓
Conductance	✗	✓	✓

Electrical conductivity :

Covalent Compounds

	Solid.	aq.	liquid (Molten)
Presence of ions.	✗	✓	✗
Mobility of Ions	✗	✓	✗
Conductance	✗	✓	✗

* Metals can Conduct electricity in all state due to presence of Free e^-

Q Which of the Following Pair can Conduct electricity

(1) $KCl_{(s)}$, $HCl_{(\ell)}$

(2) $Fe_{(s)}$ $KCl_{(s)}$

(3) $Fe_{(s)}$ $HCl_{(s)}$

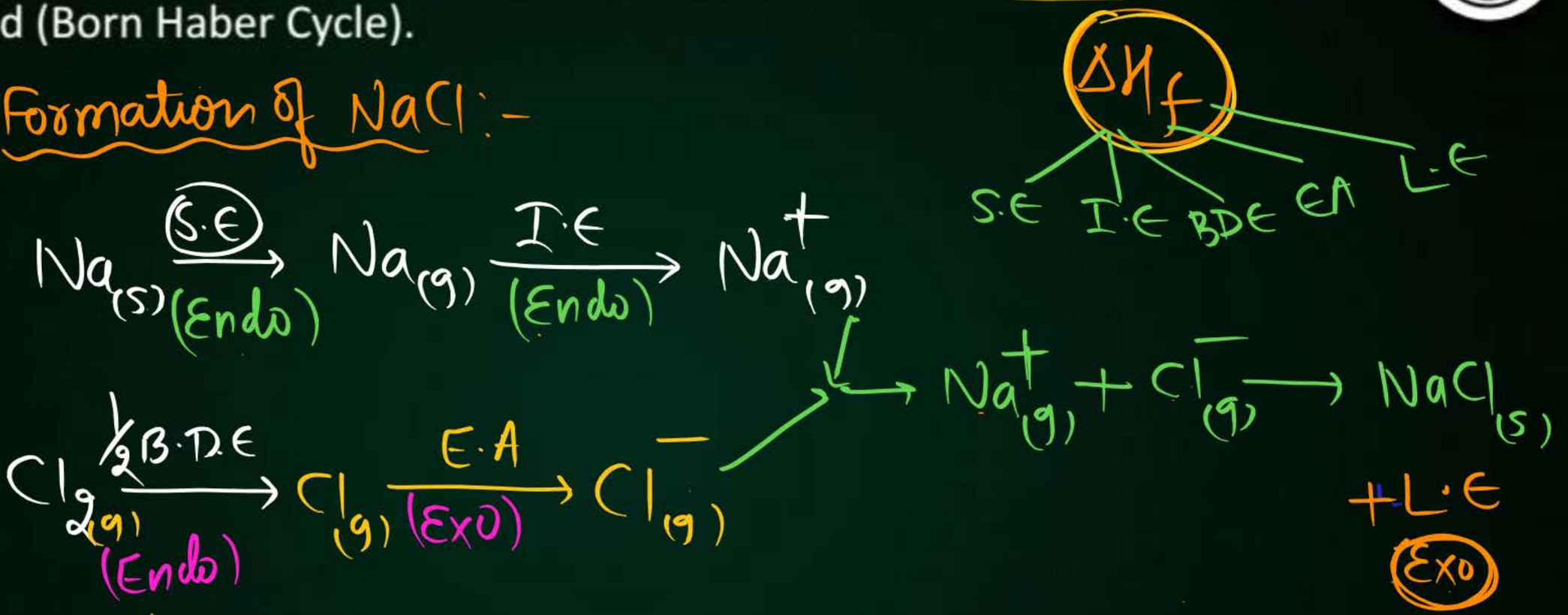
(4) $KCl_{(\ell)}$ $HCl_{(aq)}$

HCl → covalent

KCl ionic

- To form a stable ionic compound released energy must be greater than energy absorbed (Born Haber Cycle).

Ex Formation of NaCl :-



MDJ

For stable ionic Compound

Exo > Endo

Released Energy > Absorbed Energy.

E.A , L.E > S.E , B.D.E , I.E

of Non Metal

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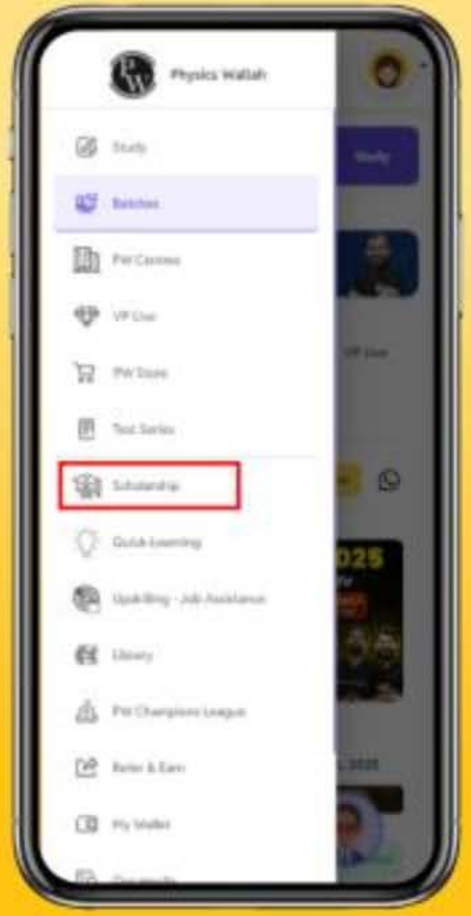

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1 October 2024
Time
Duration
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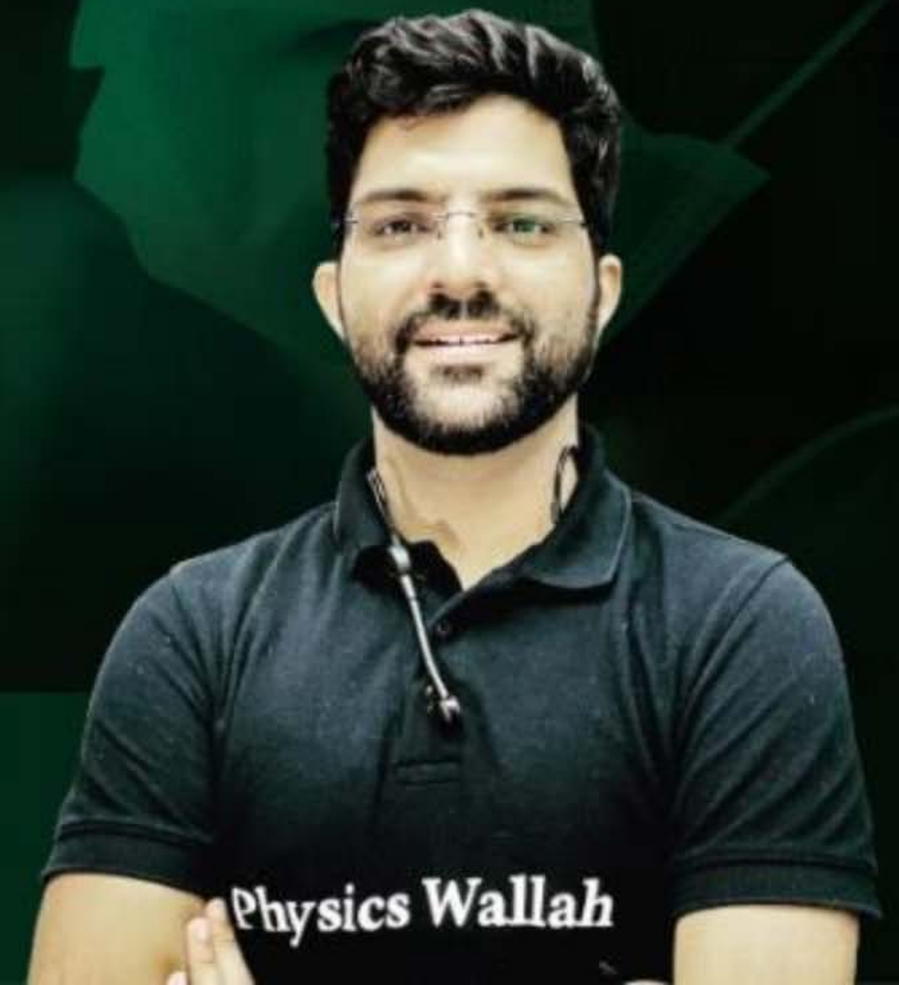
Lecture - 12 | Inorganic Chemistry

Chemical Bonding & Molecular Structure

By - Mohit Dadheech (MD Sir)



Topics *to be covered*

1. Lattice Energy
2. Fajan's Rule

Lattice Energy (U) :

Lattice Energy (U) :

Amount of energy released when 1 mole of ionic solid is formed by its constituents gaseous ions.

MDJ

$U \propto |q_1||q_2|$

If charge Same then

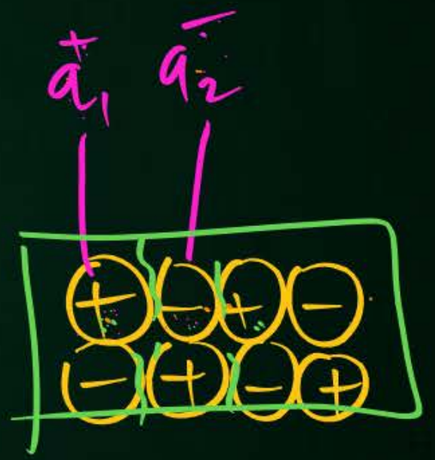
$U \propto \frac{1}{\gamma}$

$M^+_{(g)} + X^-_{(g)} \longrightarrow MX_{(s)} + \text{L.E. (U)}$

$U = -\frac{Aq_1q_2}{r} + \frac{B}{r^n}$

Attraction

Repulsion Negligible



γ

QUESTION

Give correct order of L.E. in following

$NaF > NaCl$

$NaCl < Na_2O$

$KCl > RbCl$

$KCl < K_2O$

$MgO > Na_2O$

$MgO < Al_2O_3$

$Li_3N > Na_3N$ * non existing due to very low L.E

$Na_2O > Na_2S$

N^{3-} Nitride

Alkaline earth metals Nitride Exist

Group-I Alkali metals Only Li_3N Exist.

QUESTION

The stability of ionic crystal principally depends on :

1. High electron affinity of anion forming species
2. The lattice energy of crystal
3. Low I.E. of cation forming species
4. Low heat of sublimation of cation forming solid

QUESTION

Solid NaCl is a bad conductor of electricity because :

1. In solid NaCl, there are no ions
2. Solid NaCl is covalent
3. In solid NaCl, there is no mobility of ions
4. In solid NaCl, there are no electrons

QUESTION

The order of increasing lattice energy of the following salt is :

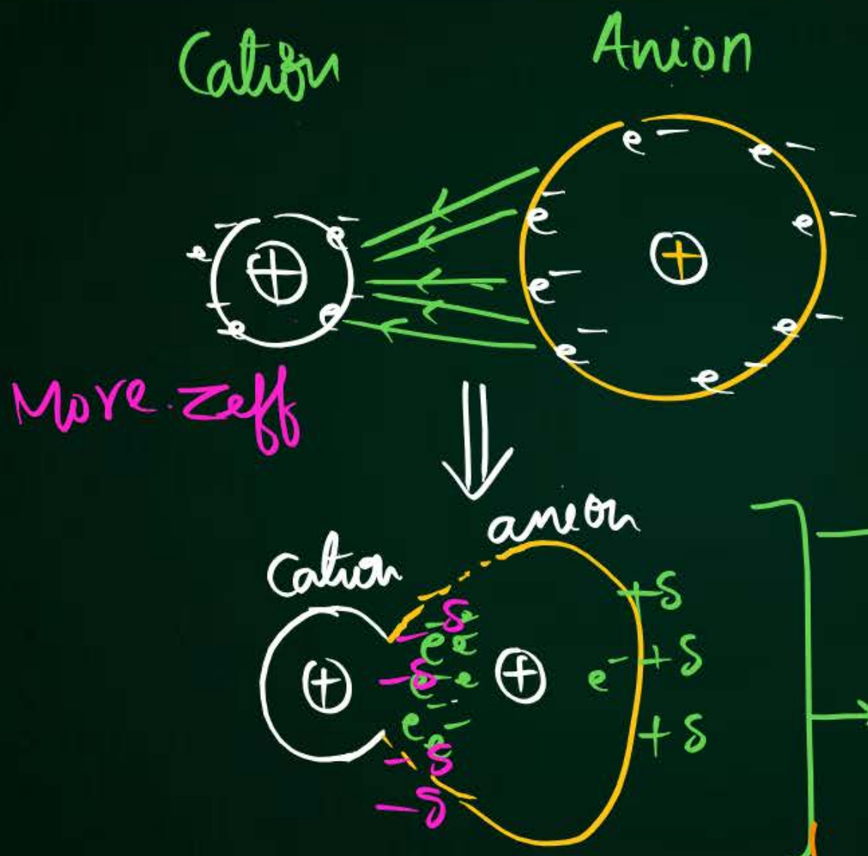
1. NaCl < CaO < NaBr < BaO
2. NaCl < NaBr < CaO < BaO
3. NaBr < NaCl < BaO < CaO
4. NaCl < CaO < BaO < NaBr

Development of covalent character in ionic compounds (Fajan's Rule) :

Cation

$p^+ > e^-$

Z_{eff} ↑se



- Polarisation in anion's e^- cloud (distortion)
- Merging of e^- clouds of cation & anion → overlapping
- Covalent character ↑se

when polarisation ↑se ⟶ Covalent ch. ↑se.

① when polarising Power (ϕ) of cation Increase

$$\phi \propto \frac{q^+}{r^+}$$

→ Small cation

→ High charge on Cation

② when polarisability of Anion ↑se.

Polarisability $\propto q^- \propto r^-$

→ Large anion

→ High charge on anion.

$\overset{+\delta}{A}-\overset{-\delta}{B}$

Covalent

Diff ↑se

% Ionic ch.

Bond polarity ↑

$A^{+}\sim B^{-}$

Ionic

Polar

Cov ↑

c

depolarization of Compound

Conditions for maximum covalent character :

- Small cation
- Large anion
- High charge on cation
- High charge on anion

(1) $F^- < Cl^- < Br^- < I^-$ (Polarisability)

(2) $Be^{2+} > Mg^{2+} > Ca^{2+} > Sr^{2+} > Ba^{2+}$ (Polarising Power)

ϕ

$\phi \propto \frac{q.t}{r.t}$

In a group

Top to Bottom

$r.t \uparrow \phi \downarrow$

③ $M^{+} < M^{2+} < M^{3+}$

④ $Cr^{2+} < Cr^{3+} < Cr^{+6}$

⑤ $Mn^{2+} < Mn^{+4} < Mn^{+7}$

⑥ $Fe^{2+} < Fe^{3+}$

⑦ $Sn^{2+} < Sn^{+4}$

} Polarising power

⑧ $O^{-} < O^{2-}$

⑨ $X^{-} < X^{2-} < X^{3-}$

} Polarisability

Important Points

(i) Na^+, K^+, Rb^+, Cs^+ = Low ϕ

(ii) d block cations have more polarising power (ϕ) than s block cation.

Size ↓

ϕ ↑

(iii) LiCl, $BeCl_2$, $MgCl_2$ soluble in organic solvents like benzene, pyridine and acetone.

↳ small cation, very high ϕ, max. covalent ch → soluble in non polar solvent.

(iv) Due to covalent character M.P. of ionic compounds decreases.

$\therefore$ $\overset{+2}{Sn}Cl_2 < \overset{+4}{Sn}Cl_4$ (cov. ch.)

$\therefore$ $SnCl_2 > SnCl_4$ (M.P)

QUESTION

Give correct order of covalent character in following :

$NaF < NaCl < NaBr < NaI$ ($F^- < Cl^- < Br^- < I^-$ Polarisability ↑, Polarisation ↑

$LiF < LiCl < LiBr < LiI$

$SnCl_2 < SnCl_4$ $q^+ \uparrow, \phi \uparrow$, Cov. ch ↑

$NaCl < CuCl$

$CaCl_2 < CdCl_2$

$FeCl_2 < FeCl_3$

QUESTION

Al^{3+} $3F^-$ Ionic.

Give correct order of covalent character in following :

$AlF_3 < AlCl_3 < AlBr_3 < AlI_3$

$NaCl < ZnCl_2 < SiCl_4 < AgF < AgCl < AgBr < AgI$

$HgF_2 < HgCl_2 < HgBr_2 < HgI_2$

$PbF_2 < PbCl_2 < PbBr_2 < PbI_2$

$SiCl_4$ → Completely Covalent

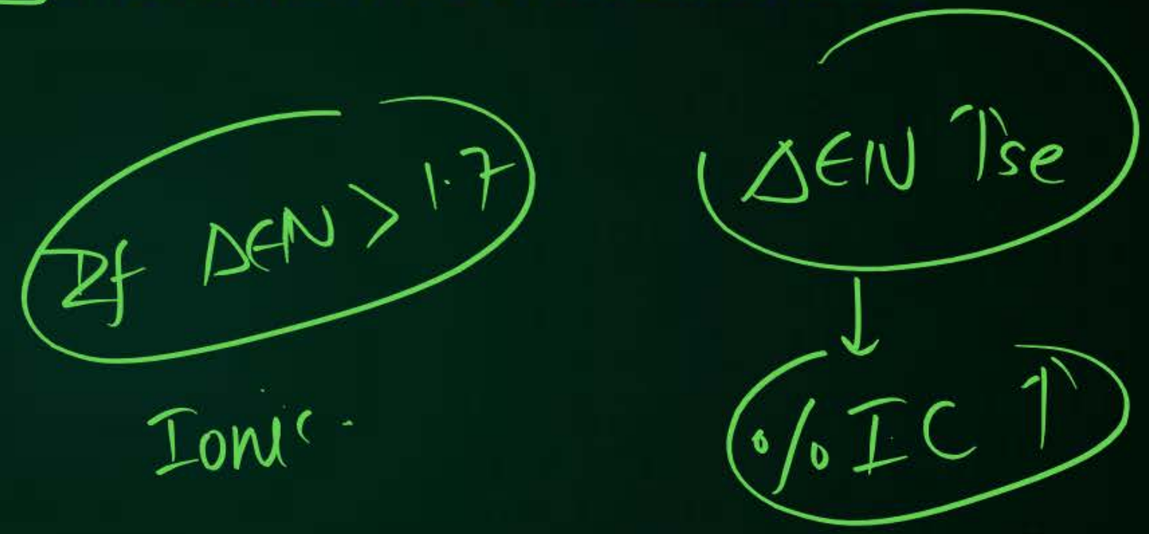
$SiCl_4$
AB_4L_0, sp^3
Tetrahedral

$LiI > NaBr > KCl > RbF$

QUESTION

Element X is strongly electropositive and element Y is strongly electronegative. Both are univalent. The compound formed would be

1. X^+, Y^-
2. X^-, Y^+
3. X - Y
4. $X \rightarrow Y$



QUESTION

Statement-I : LiCl is predominantly a covalent compound.

Statement-II : The electronegativity difference between Li and Cl is too small.

LiCl

Covalent

(Reason) → due to High degree of Polarisation in Anion's e^- cloud.

(Li^+) ($\gamma+ \downarrow \phi \uparrow$)

St. I → True

St. II → False

QUESTION

In an ionic compound A^+X^- the degree of covalent bonding is greatest when:

1. A^+ and X^- ion are small
2. A^+ is small and X^- is large
3. A^+ and X^- ions are approximately of the same size
4. X^- is small and A^+ is large

Homework

From Module – 1

Question Based on Ionic Bond

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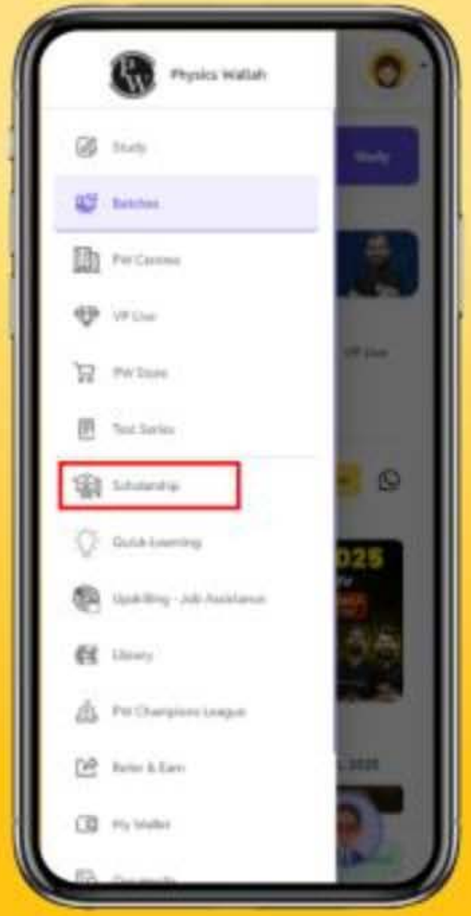

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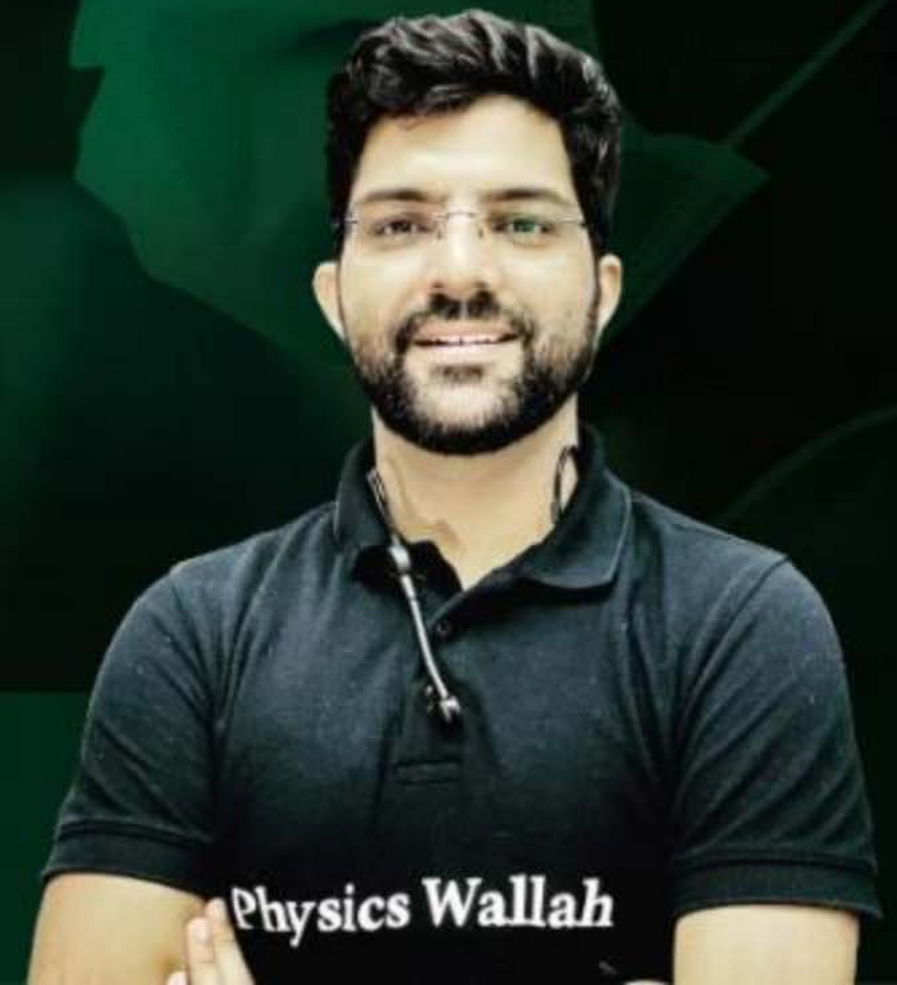
Lecture - 13 | Inorganic Chemistry

Chemical Bonding & Molecular Structure

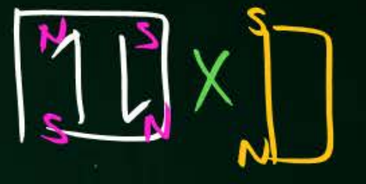
By - Mohit Dadheech (MD Sir)



Topics *to be covered*

1. Molecular Orbital Theory

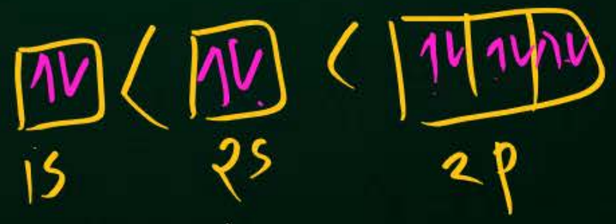
Molecular Orbital Theory



- Paramagnetic behavior of O_2 is explained by MOT.
- As per our syllabus we will study this theory only for homodiatomic molecules (total electrons upto 20).

N_2 B_2 C_2 H_2, Li_2, O_2, F_2, Ne_2
14e⁻ 10e⁻ 12e⁻ 2e⁻ 6e⁻ 16e⁻ 18e⁻ (20e⁻)

- Acc. to MOT when two atomic orbitals of almost similar energy and same symmetry interact with each other two new molecular orbitals formed of diff. energy.
- The molecular orbitals like atomic orbitals are filled in accordance with the aufbau principle obeying the Pauli's exclusion principle and the Hund's rule.

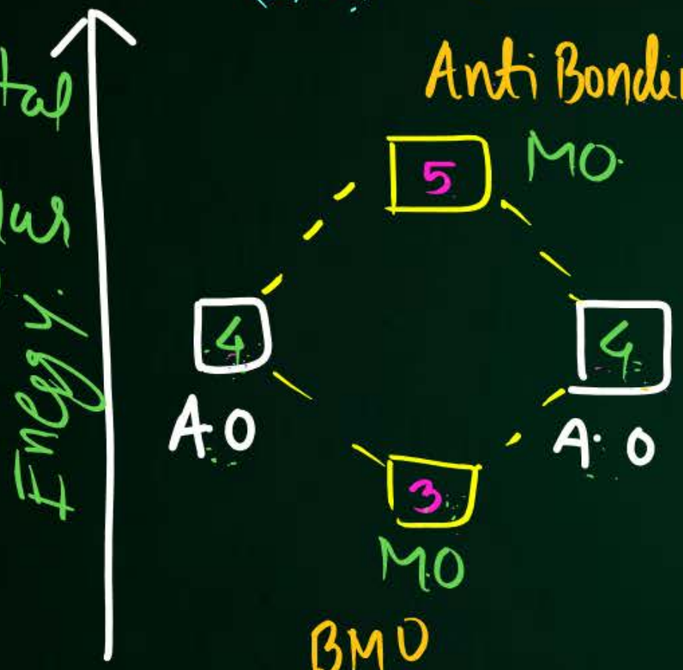


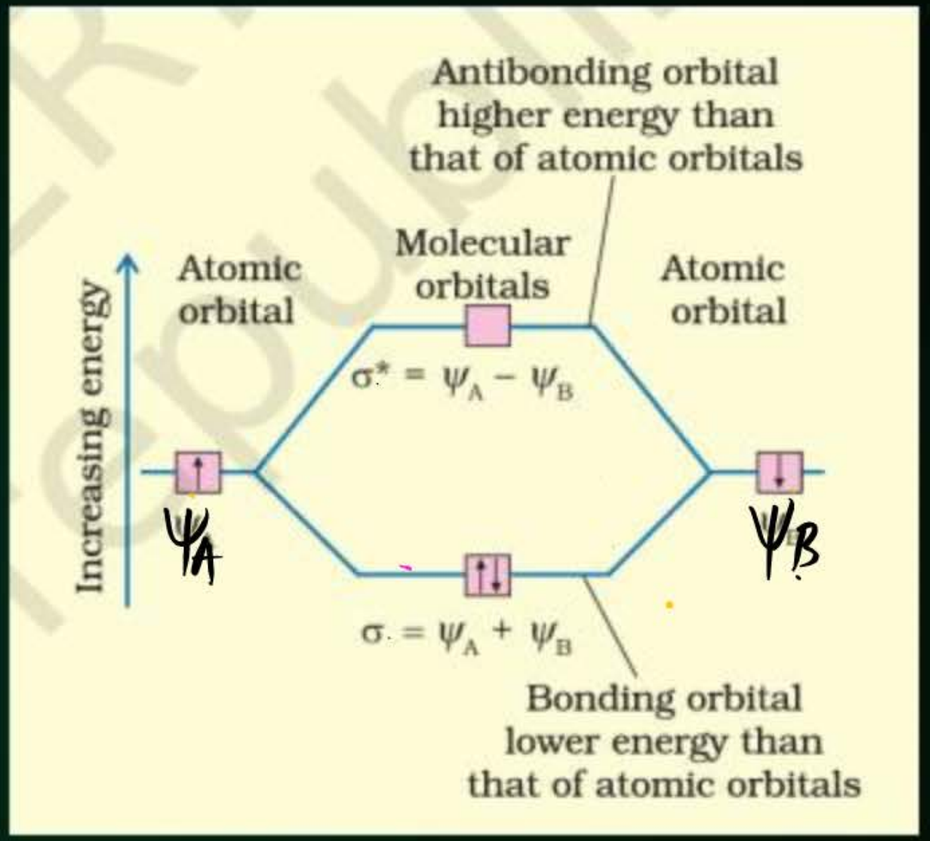
Molecular Orbital Theory

Jitne Milenge – Utne Banenge
(A.O) (M.O)

AO → Atomic orbital

MO → Molecular Orbital





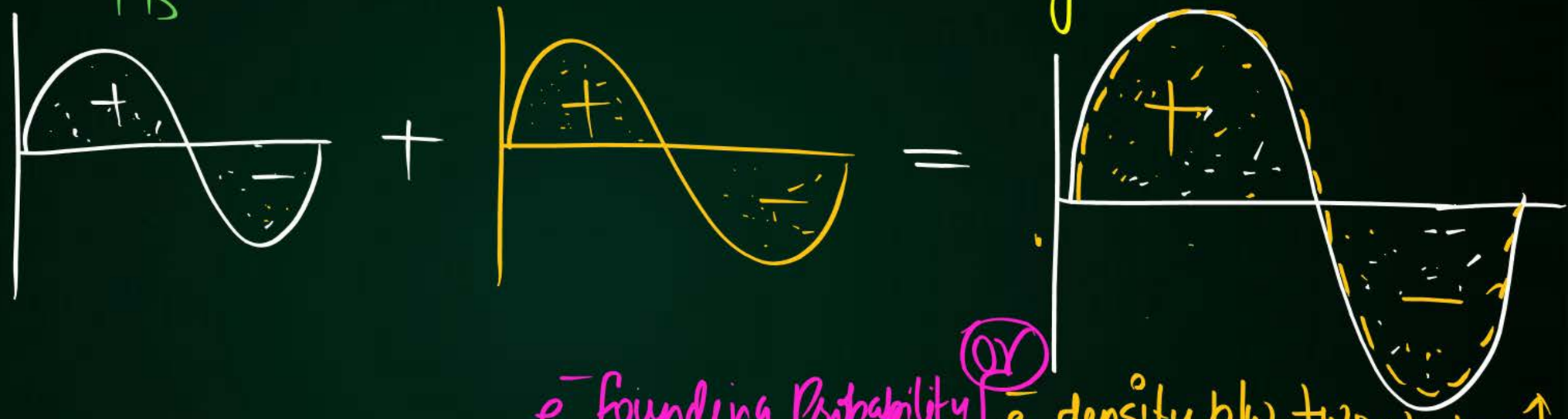
$\psi_{(AB)} = \psi_A \pm \psi_B$

Constructive Interference :

$$\psi_{BMO} = \psi_A + \psi_B$$

Formation of (BMO)

Bonding Molecular Orbital



e^- founding Probability ↑ (ψ) e^- density b/w two Nucleus ↑se

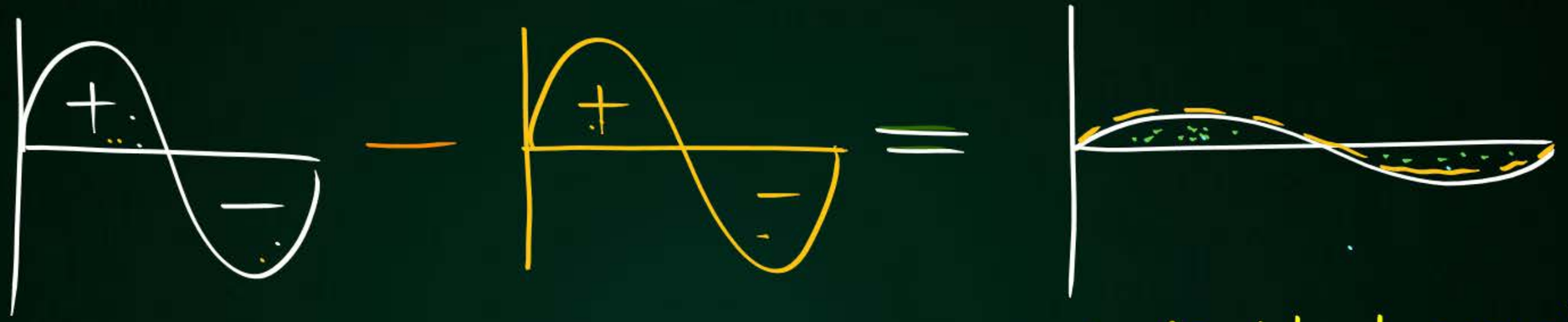
b/w Nucleus ↑se

Bond Banega → Attraction ↑se

Energy ↓se

Destructive Interference :

Formation of ABMO.



→ $\bar{e}$ density b/w two nucleus ↓se.

→ Repulsion ↑e

→ Energy High.

Electronic Configuration : $\Rightarrow$ (e^- Filling into Molecular orbitals)

(O_2, F_2, Ne_2)

Beyond N_2 $\Rightarrow$ Normal, without s-p mixing, MDJ $\Rightarrow$ 1221

Up to N_2 $\Rightarrow$ Exceptional, with s-p mixing, MDJ $\Rightarrow$ 2121

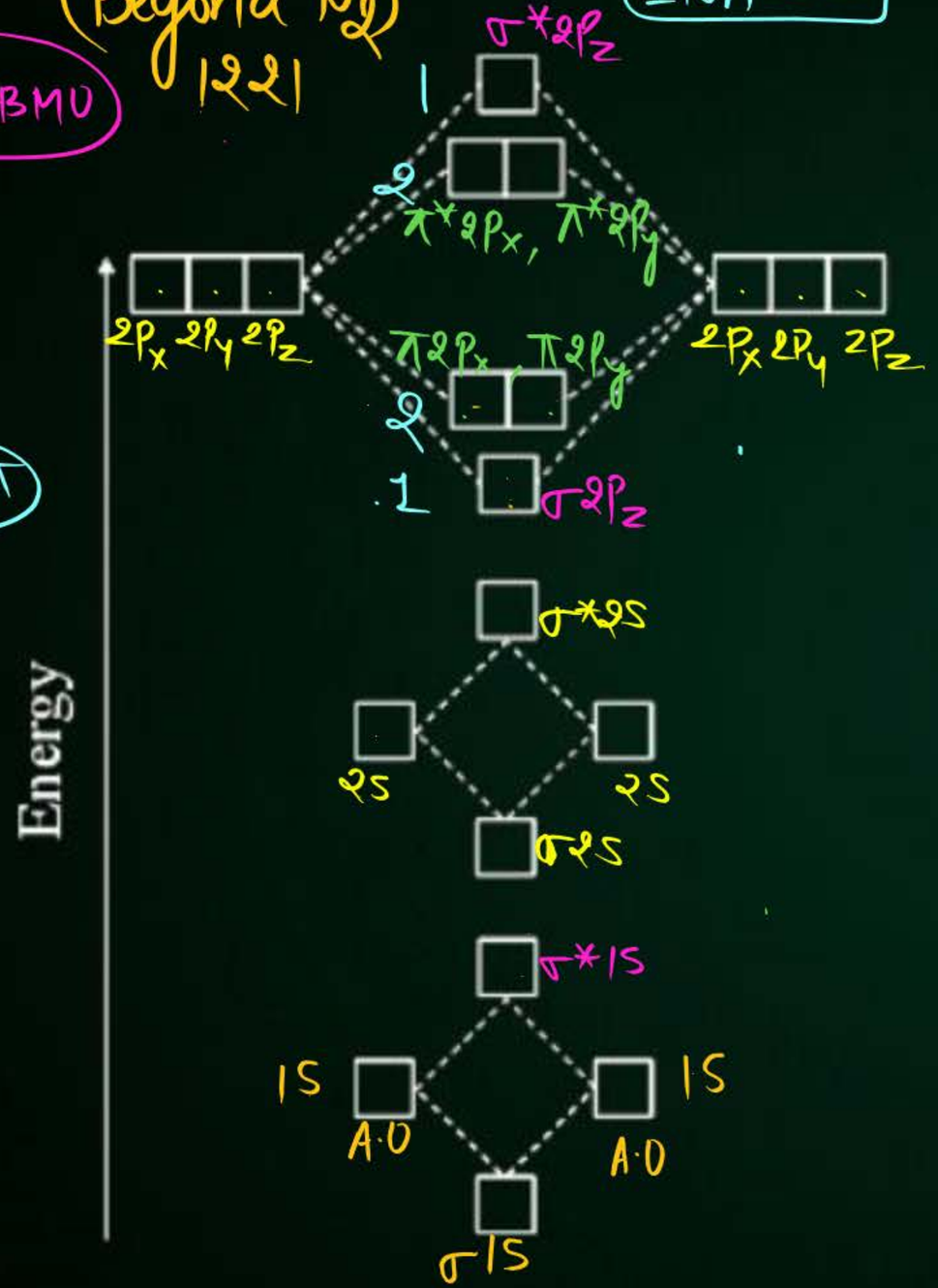
(H_2 to N_2)

(Beyond N_2)
1221

INA = Z

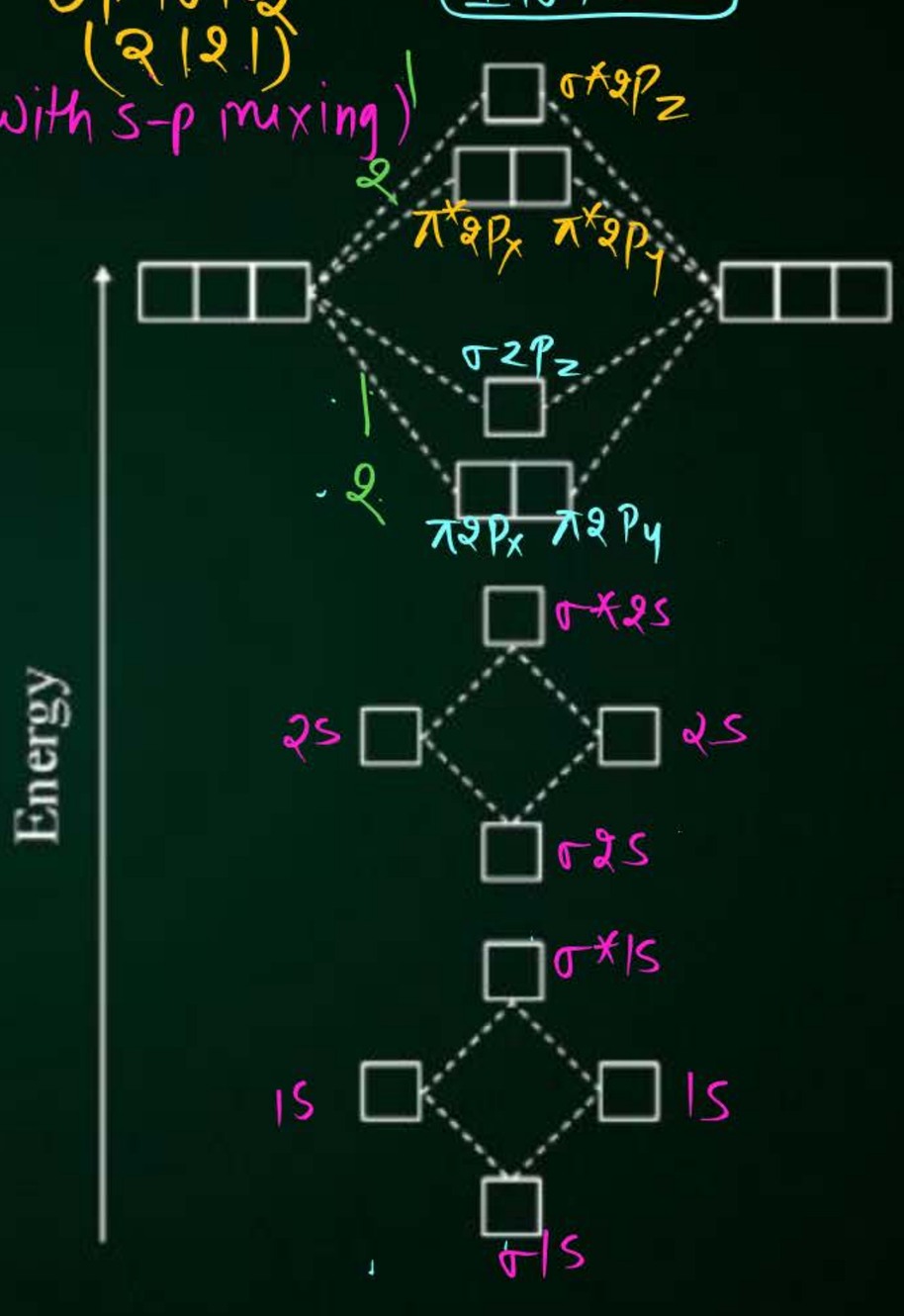
(* → ABMU)

(σ > π)



Up to N_2
(2121)
(with s-p mixing)

INA = Z



Beyond N_2 (1221)

$\sigma 1s < \sigma^* 1s < \sigma 2s < \sigma^* 2s < \sigma 2p_z <$ ($\pi 2p_x$ = $\pi 2p_y$) $<$ ($\pi^* 2p_x$ = $\pi^* 2p_y$) $< \sigma^* 2p_z$

Up to N_2

$\sigma 1s < \sigma^* 1s < \sigma 2s < \sigma^* 2s <$ ($\pi 2p_x$ = $\pi 2p_y$) $< \sigma 2p_z <$ ($\pi^* 2p_x$ = $\pi^* 2p_y$) $< \sigma^* 2p_z$

2121

Upto N_2

$N_2 \Rightarrow 14e^-$ (7+7)

$\sigma 1s < \sigma^* 1s < \sigma 2s < \sigma^* 2s <$ $\pi 2p_x = \pi 2p_y$ $< \sigma 2p_z$

OMO

HOMO for N_2

$< \pi^* 2p_x = \pi^* 2p_y < \sigma^* 2p_z$

LUMO for N_2

UMO

LOMO

HUMO

Highest OMO

HOMO

OMO → occupied MO

UMO → Unoccupied MO

LUMO → Lowest UMO

For O_2 (1221)

$8+8=16e^-$

$\sigma 1s < \sigma^* 1s < \sigma 2s < \sigma^* 2s < \sigma 2p_z < \pi 2p_x = \pi 2p_y < \pi^* 2p_x = \pi^* 2p_y < \sigma^* 2p_z$

$\pi 2p_x$: ↑↓ ; $\pi 2p_y$: ↑↓ ; $\pi^* 2p_x$: ↑ ; $\pi^* 2p_y$: ↑

2 Unpaired e^- are present in $\pi^*/\pi ABMO$ thats why O_2 is Paramagnetic

≠ MDJ

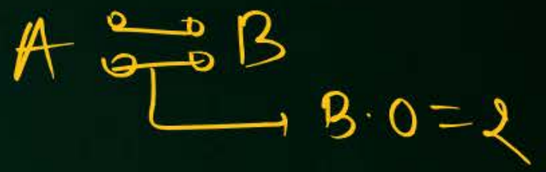
If

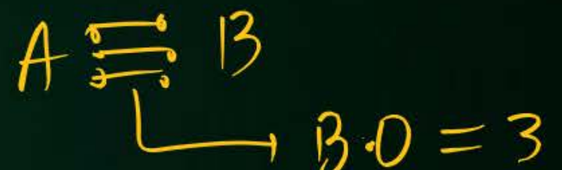
1 e^- ↑se in BMO → B.O ↑se by 0.5

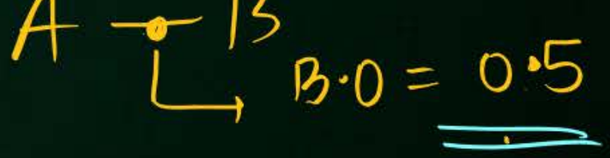
1 e^- ↓se From BMO → B.O ↓se by 0.5

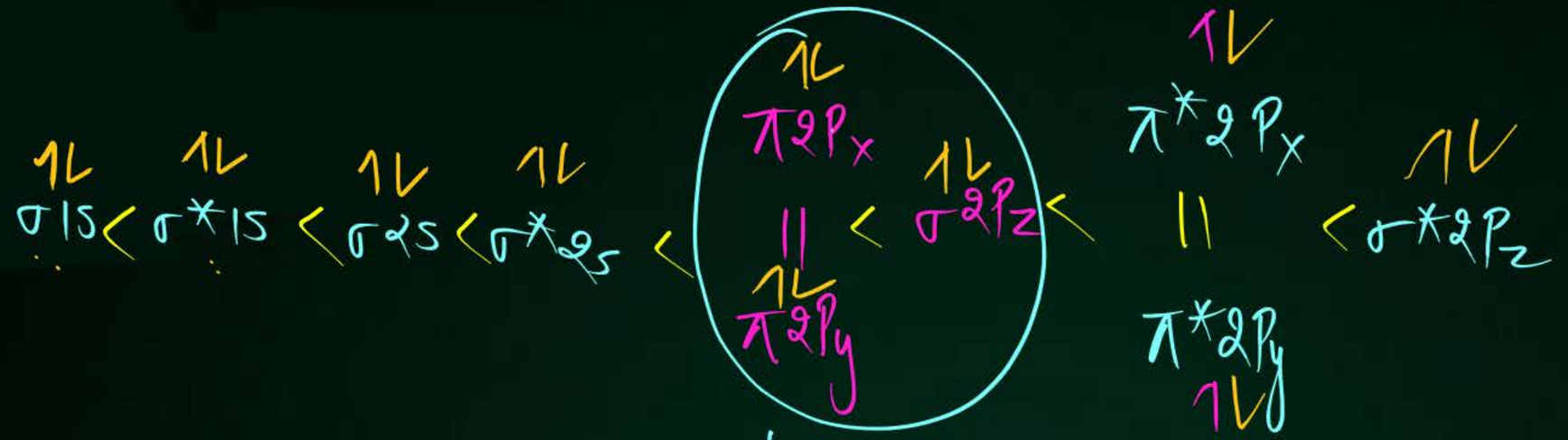
1 e^- ↑se in ABMO → B.O ↓se by 0.5

1 e^- ↓se From ABMO → B.O ↑se by 0.5









Total e^-	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
B.O	0	0.5	1	0.5	0	0.5	1	0.5	0	0.5	1	1.5	2.0	2.5	3.0	2.5	2.0	1.5	1.0	0.5	0

e^- Use From BMO → B.O Use

e^- Use in ABMO → B.O Use

Bond order Formula

$$B.O = \frac{\text{Total BMO } e^- - \text{Total ABMO } e^-}{2}$$

QUESTION

Which of the following M.O. are degenerated (INA is z)

1. $\sigma 1s, \sigma^* 1s$

2. $\pi 2p_x, \pi^* 2p_x$

3. $\pi 2p_x, \pi 2p_y$

4. $\sigma 2p_z, \pi 2p_x$

Magnetic Nature

Total e^-

odd no.

Paramagnetic.

even no.

Diamagnetic

Except B_2, O_2, S_2

130S

Para

Homework

Find B.O & Magnetic Nature (Para / Dia) in Following species.

1. N_2
2. N_2^+
3. O_2^+
4. O_2
5. B_2
6. C_2
7. F_2
8. O_2^{2+}
9. O_2^{2-}
10. O_2^-
11. C_2^-
12. Li_2
13. Be_2^+
14. He_2
15. Ne_2
16. Be_2
17. H_2^{2-}
18. H_2

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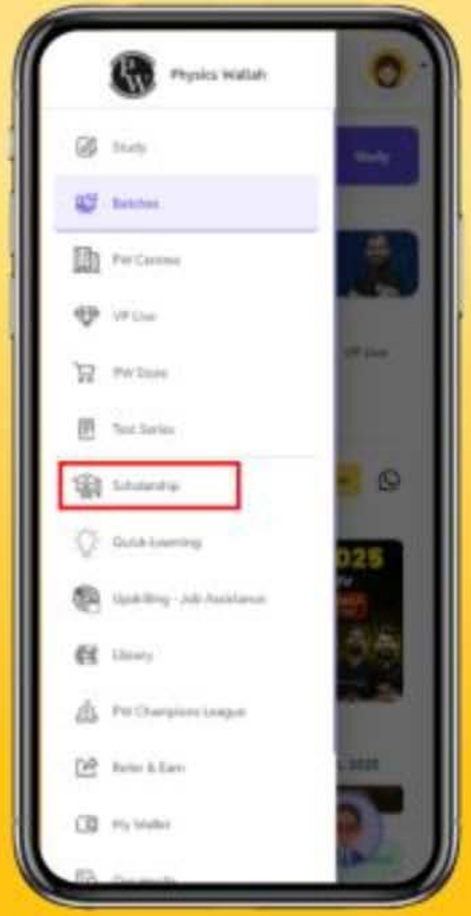

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1 October 2024
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Duration
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The exam will be proctored.
Candidates will be asked to turn on the camera and microphone as needed.
Candidates are suggested not to switch tabs on Desktop or App on Mobile during the test to avoid auto submission.
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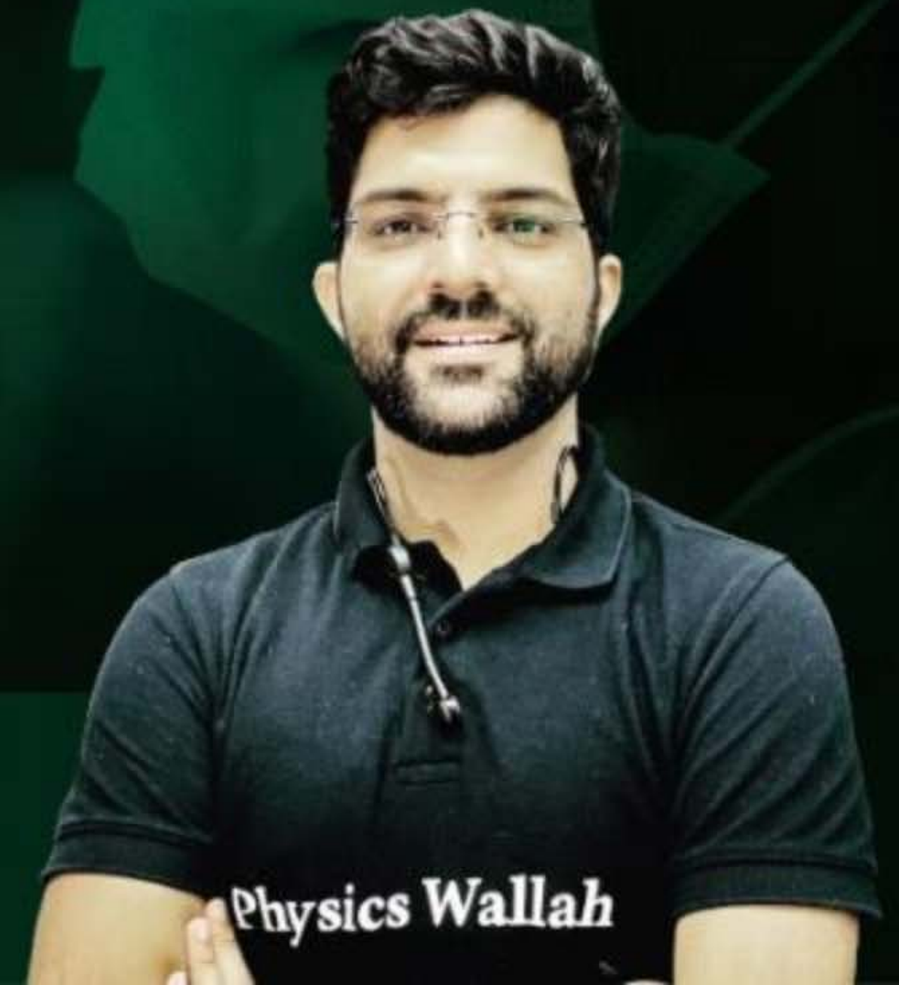
FOR NEET 2025

Lecture - 14 | Inorganic Chemistry

Chemical Bonding & Molecular Structure

By - Mohit Dadheech (MD Sir)



Topics *to be covered*

1. Molecular Orbital Theory (Remaining Part)
2. H-Bonding

Homework

Find B.O & Magnetic Nature (Para / Dia) in Following species.

1. N_2 14, dia
2. N_2^+ 2.5, P
3. O_2^+ 2.5, P
*4. O_2 2, ~~P~~
*5. B_2 1, P ~~D~~
6. C_2 2, D
7. F_2 1, D
8. O_2^{2+} 3, D
9. O_2^{2-} 1, D
10. O_2^- 1.5, P
11. C_2^- 2.5, P
12. Li_2 1, D
13. Be_2^+ 0.5, P
14. He_2
15. Ne_2
16. Be_2
17. H_2^{2-}

doesnot Exist Because B.O = 0

18. H_2 1, D

SOME IMP. POINTS

NOTE

Generally B.O ↑se (no. of Bonds ↑se)

Bond strength ↑se

Bond length ↓se

B.O ∝ stability

* If B.O. of two species are same then stability $\propto \frac{1}{\text{ABMO } e^-}$

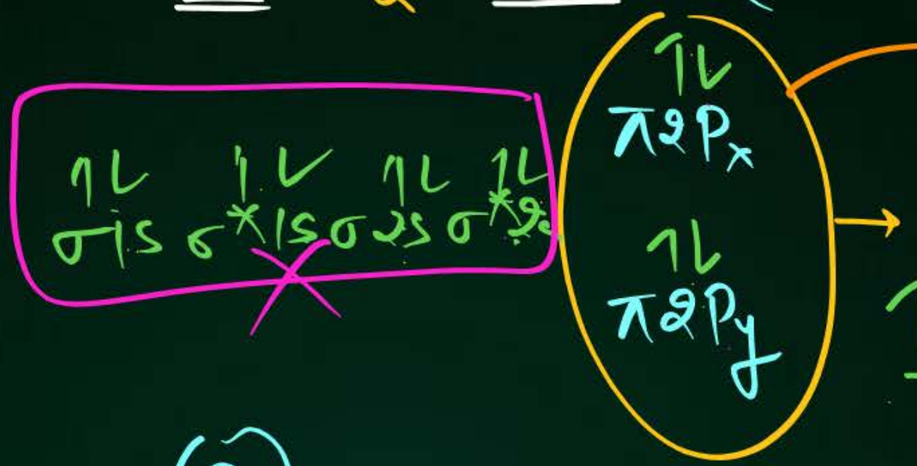
Ex ≡	Li_2	Li_2^+	Li_2^-
B.O	(1)	0.5	0.5
ABMO e^-	2	2	3

$Li_2 > Li_2^+ > Li_2^-$ (stability)

Bond order

- σ Bond order
- π Bond order.

Ex C_2 $12e^-$ (2121)



4 π BMO e^-
∴ 2 π Bonds.
Bond order = 2

Type of Bond. ⇒ (π)

C_2 → gas

exist at high temp

$\frac{8-4}{2} = 2$

$\frac{4-0}{2} = 2$

Ex B_2 $10e^-$ (2121)

Bond order → 1

Type → π

Only 1 π is present

2121

Upto N_2

$N_2 \Rightarrow 14e^-$ (7+7)

↑↓ ↑↓ ↑↓ ↑↓

$\sigma 1s < \sigma^* 1s < \sigma 2s < \sigma^* 2s <$

↑↓ $\pi 2p_x$ ↑↓ $< \sigma 2p_z <$

$\pi 2p_y$ ↑↓

$\pi^* 2p_x$ || $< \sigma^* 2p_z$

$\pi^* 2p_y$

$$\frac{10-4}{2} = \frac{6}{2} = 3$$

Total 6 BMO $e^- \Rightarrow$ B.O = (3)

4 π BMO e^- 2 σ BMO e^-

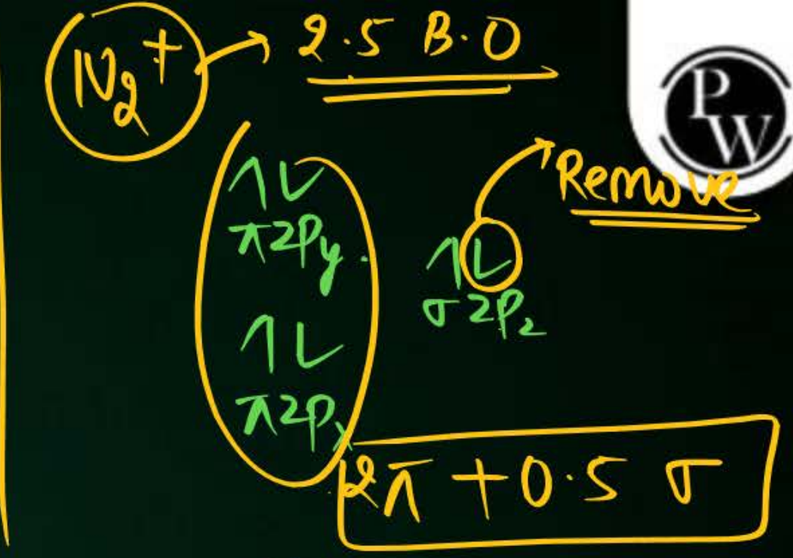
$2\pi + 1\sigma \Rightarrow$ (3)

$N_2 \longrightarrow N_2^-$

$1e^-$ addition into π ABMO.

B.O ↓se by 0.5

B.O = 2.5



Q. Correct B.O of N_2^- → $15e^- \Rightarrow$ B.O = 2.5

(1) $1.5\sigma + 1\pi$

(2) $2\pi + 0.5\sigma$

(3) $1.5\pi + 1\sigma$

(4) All of these

For O_2 (1221)

$8+8=16e^-$

$\sigma 1s < \sigma^* 1s < \sigma 2s < \sigma^* 2s < \sigma 2p_z < \pi 2p_x = \pi 2p_y < \pi^* 2p_x = \pi^* 2p_y < \sigma^* 2p_z$

$1\sigma + (2\pi - 1\pi) \Rightarrow 1\sigma + 1\pi$

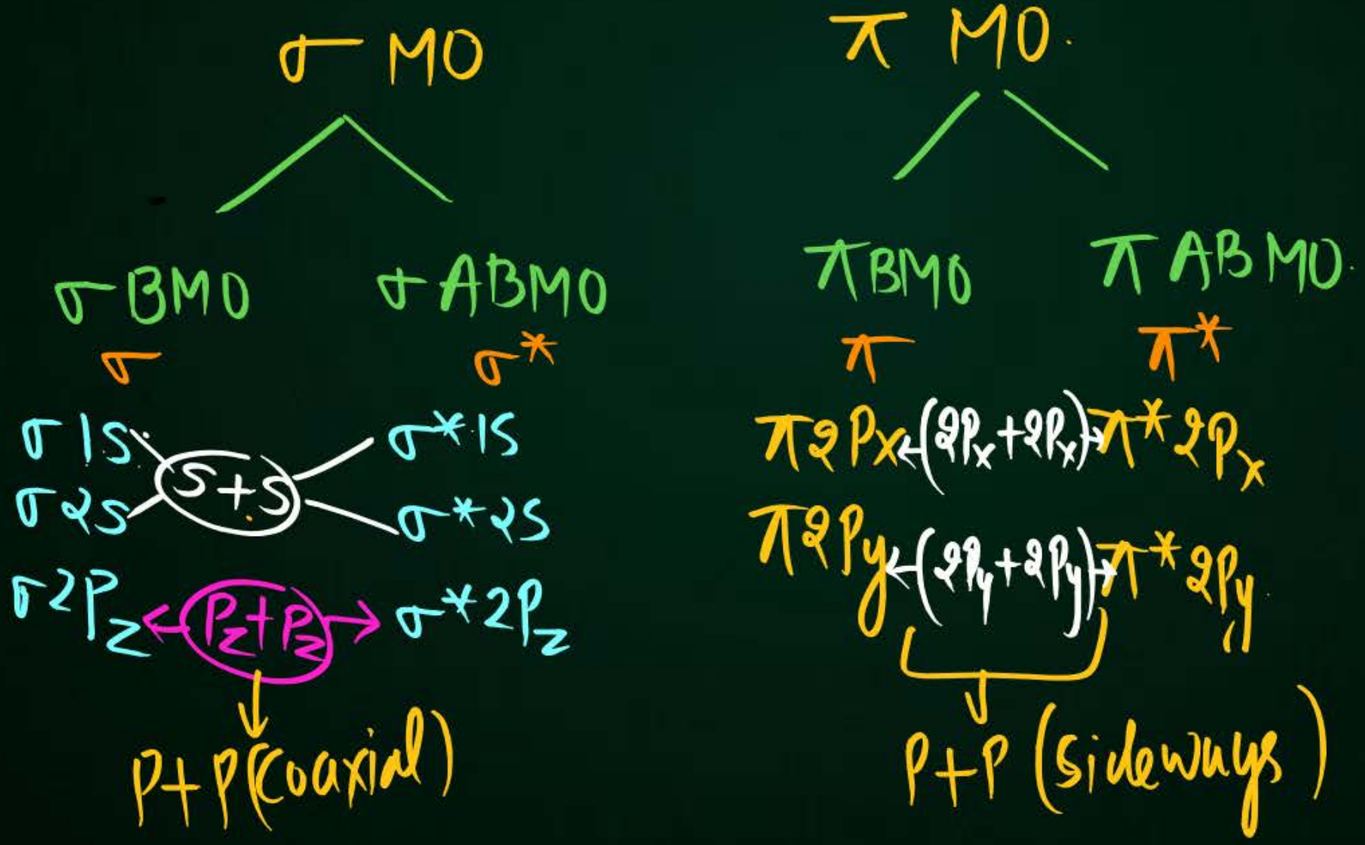
O_2^+	2.5	$(1\sigma + 1.5\pi)$
O_2^-	1.5	$(1\sigma + 0.5\pi)$
O_2^{2-}	1.0	$(1\sigma + 0\pi)$
O_2^{2+}	3.0	$(1\sigma + 2\pi)$

B.O = 2

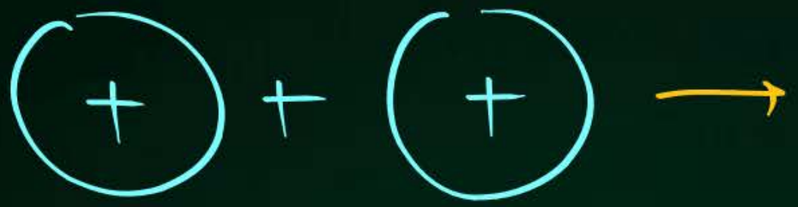
LCAO → Linear Combination of atomic Orbitals

(Formation of MOs) A.O + A.O → (MO)

INA = Z

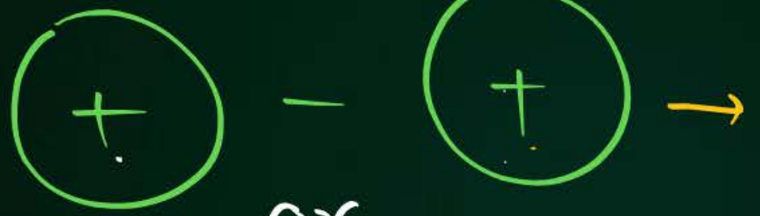


S+S

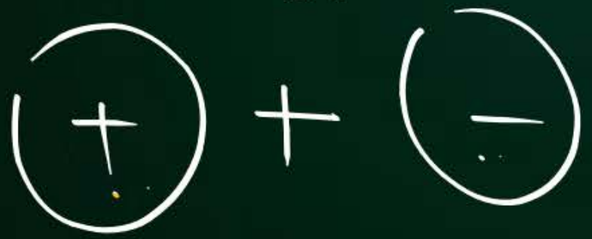


σ1S / σ2S

σ BMO



or

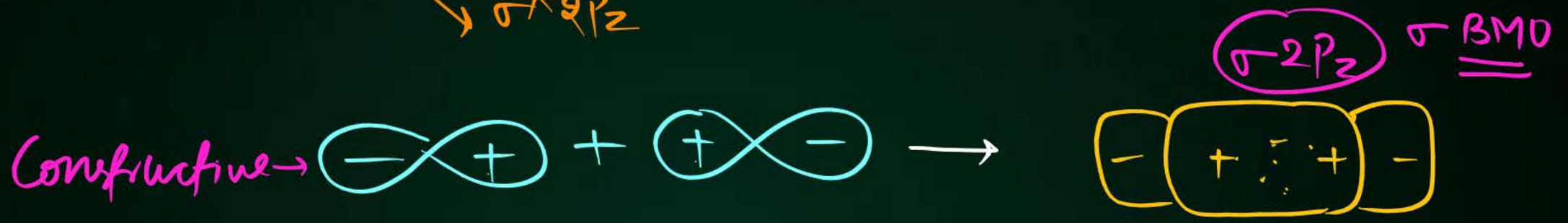


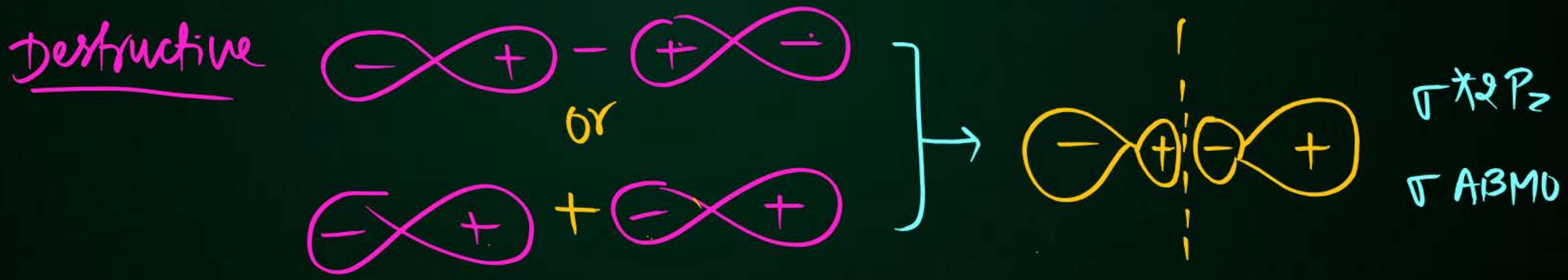
σ*1S / σ*2S

σ ABMO.

P + P Coaxial (INA = 2)

$p_z + p_z \rightarrow \sigma 2p_z$, $\sigma^* 2p_z$

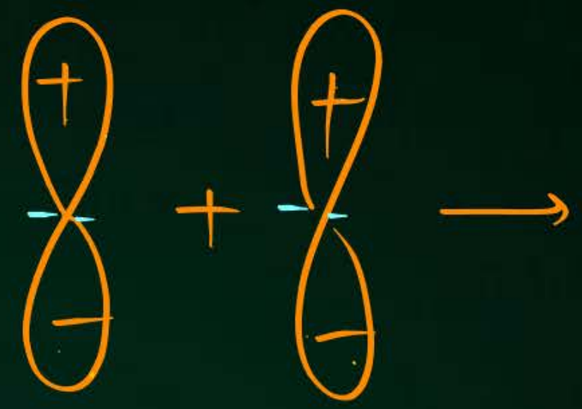


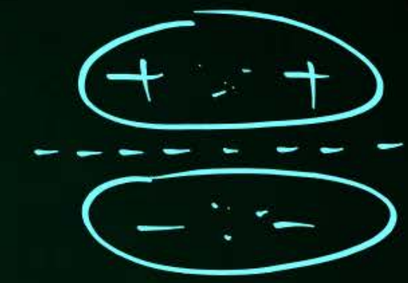


P+P (Sidewways)

$P_x + P_x$ → $\pi 2P_x$, $\pi^* 2P_x$

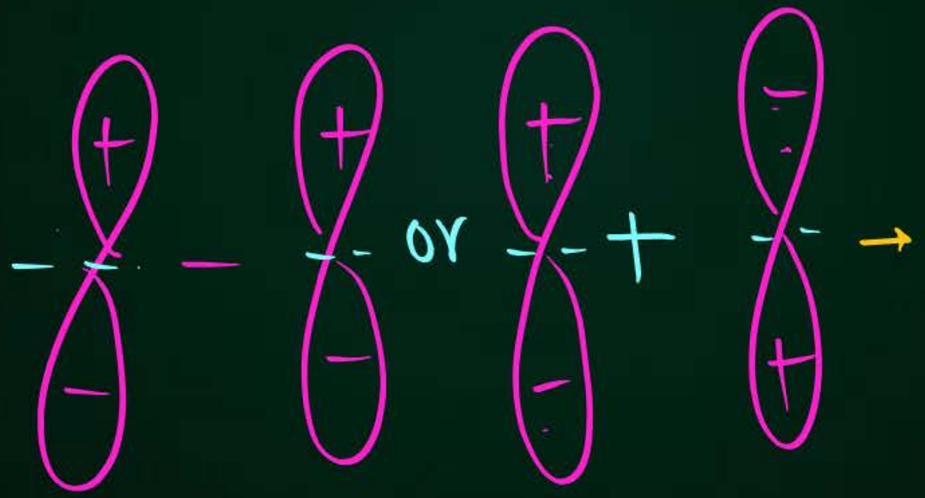
$P_y + P_y$ → $\pi 2P_y$, $\pi^* 2P_y$

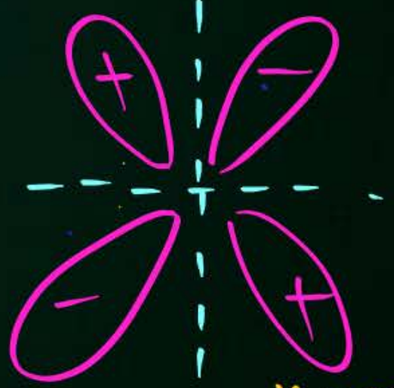




$\pi 2P_x$ / $\pi 2P_y$

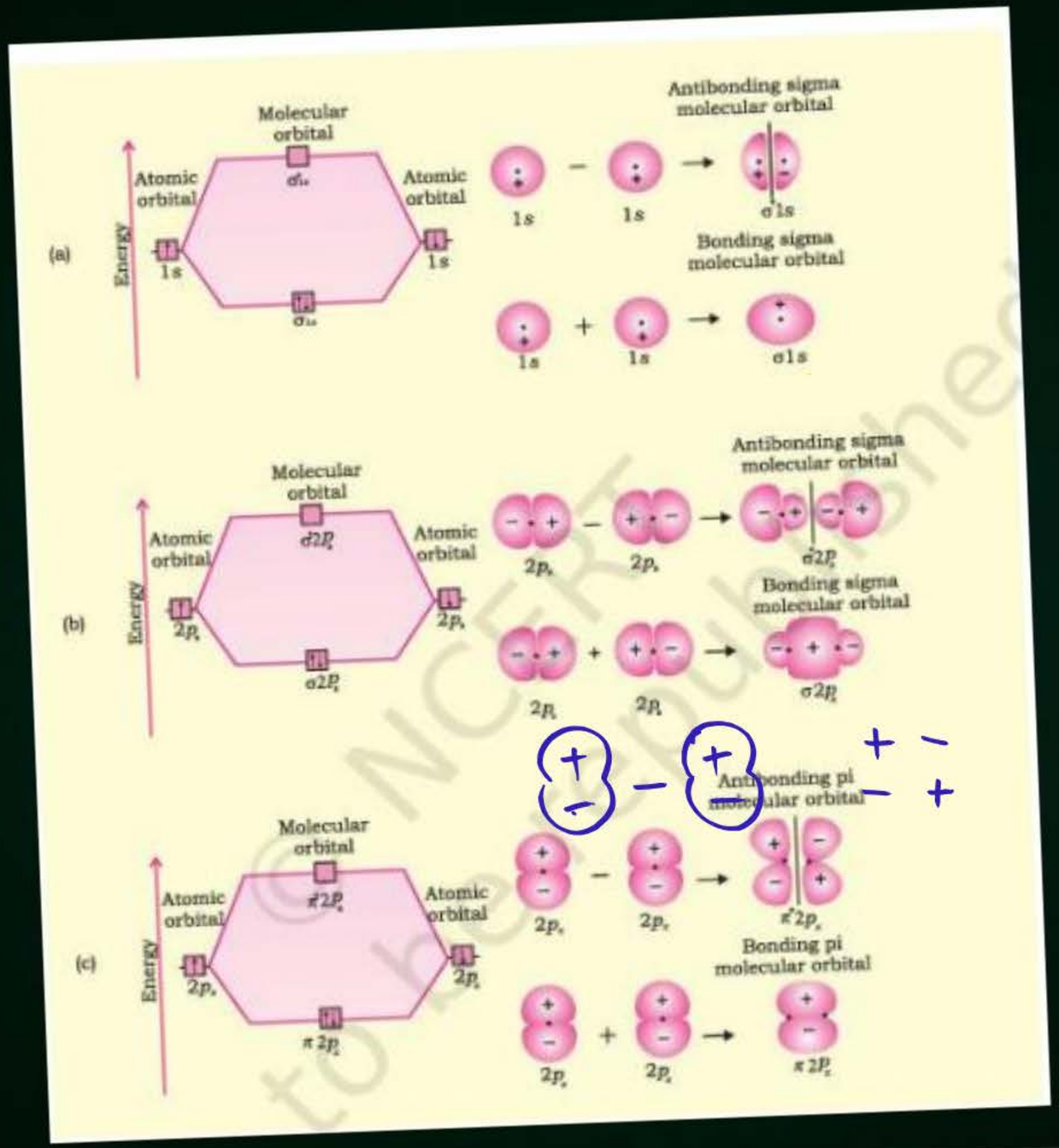
π BMO





$\pi^* 2P_x$ / $\pi^* 2P_y$

π ABMO


(a)
Molecular orbital
Atomic orbital
Atomic orbital
Energy
1s
1s
σ1s
σ*1s
Antibonding sigma molecular orbital
Bonding sigma molecular orbital
1s
1s
σ1s
(b)
Molecular orbital
Atomic orbital
Atomic orbital
Energy
2p_z
2p_z
σ2p_z
σ*2p_z
Antibonding sigma molecular orbital
Bonding sigma molecular orbital
2p_z
2p_z
σ2p_z
(c)
Molecular orbital
Atomic orbital
Atomic orbital
Energy
2p_x
2p_x
π2p_x
π*2p_x
Antibonding pi molecular orbital
Bonding pi molecular orbital
2p_x
2p_x
π2p_x

QUESTION

1221 → For all → $\sigma 2p_z$, $\pi 2p_x$, $\pi 2p_y$

If s-p mixing of orbitals is absent in following molecule, then in which of the following molecule only σ-bond is present ?

1. B_2
2. C_2
3. N_2
4. O_2

B_2: $\uparrow\downarrow$ $\sigma 2p_z$

C_2: $\uparrow\downarrow$ $\sigma 2p_z$; $\uparrow$ $\pi 2p_x$; $\uparrow$ $\pi 2p_y$

N_2: $\uparrow\downarrow$ $\sigma 2p_z$; $\uparrow\downarrow$ $\pi 2p_x$; $\uparrow\downarrow$ $\pi 2p_y$

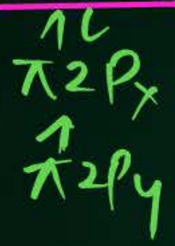
O_2: 2 ; $1\sigma + 1\pi$

1221 (Without s-p mixing) | 2121 (With s–p mixing)

QUESTION

In which of the following transformations, the bond order has increased and the magnetic behaviour has changed ?

1. $C_2^+ \rightarrow C_2$ (1.5 → 2.0; P → D)
2. $NO^+ \rightarrow NO$ (14 e⁻ → 15 e⁻; 3 → 2.5) ✗
3. $O_2 \rightarrow O_2^+$ (2.0 → 2.5; P → P) ✗
4. $N_2 \rightarrow N_2^+$ (3.0 → 2.5) ✗



QUESTION

Which of the following statement is correct ?

1. In the formation of dioxygen from oxygen atoms 10 molecular orbitals will be formed.
2. All the molecular orbitals in the dioxygen will be completely filled.
3. Total number of bonding molecule orbitals will not be same as total number of anti bonding orbitals in dioxygen.
4. Number of filled bonding orbitals will be same as number of filled anti bonding orbitals.

For O_2 (1221)

$8+8=16e^-$

$\sigma 1s < \sigma^* 1s < \sigma 2s < \sigma^* 2s < \sigma 2p_z < \pi 2p_x = \pi 2p_y < \pi^* 2p_x = \pi^* 2p_y < \sigma^* 2p_z$

$\pi 2p_x$: ↑↓ ; $\pi 2p_y$: ↑↓ ; $\pi^* 2p_x$: ↑ ; $\pi^* 2p_y$: ↑

QUESTION

Correct order of bond length is :

$B.L \propto \frac{1}{B.S/B.O}$

1. $O_2 < O_2^+ < O_2^-$
2. $O_2^+ < O_2 < O_2^-$
3. $O_2^- = O_2^+ < O_2$
4. $O_2 < O_2^+ = O_2^-$

H.W

QUESTION

Which of the following has maximum unpaired e^-

1. O_2 $n=2$
2. N_2 $n=0$
3. O_2^- $n=1$
4. O_2^{2-} $n=0$

Magnetic Moment & no. Unpaired e^-

$\mu = \sqrt{n(n+2)}$

(n=2)

$\sqrt{2(2+2)}$

$\sqrt{8}$

MDJ M.M (μ) = $\cap$ point Something

n=2 $\mu = 2.\ldots$

n=1 $\mu = 1.\ldots$

QUESTION

Which of the following has only π bonds -

1. N_2
2. B_2
3. C_2
4. Both (2) & (3)

QUESTION

Which pair of diatomic species have same bond order ?

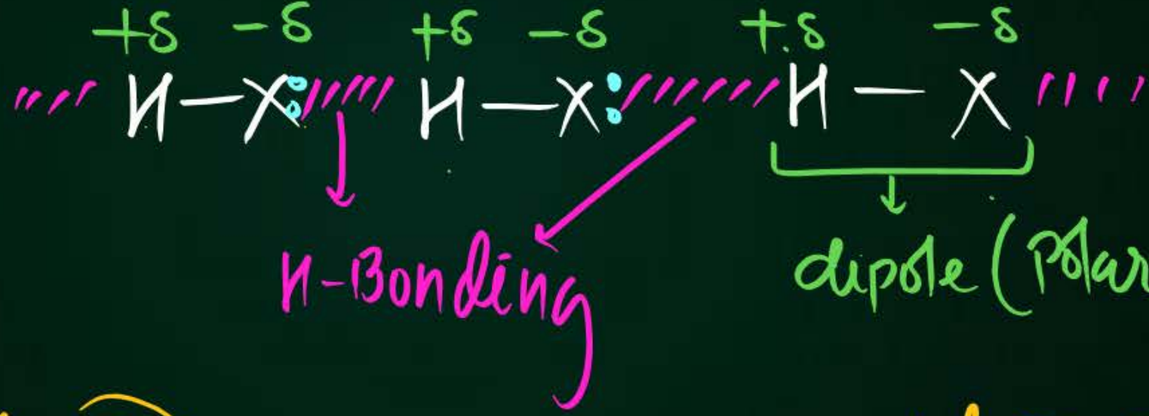
1. B_2^-, C_2
2. O_2^{2-}, F_2^-
3. N_2^+, O_2^-
4. B_2^{2-}, C_2

H.W

Hydrogen Bonding

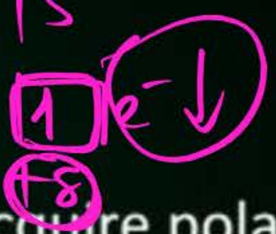
- When hydrogen is linked with high EN element like F/O/N, molecule acquire polarity and two adjacent molecules attract each other by H-bonding.

X = F/O/N

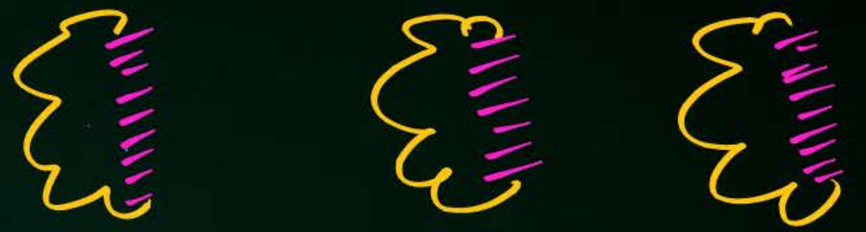


(NOTE) (1) H-Bonding is a special case of dipole-dipole Interaction

(2) l.p is essential For H-Bonding



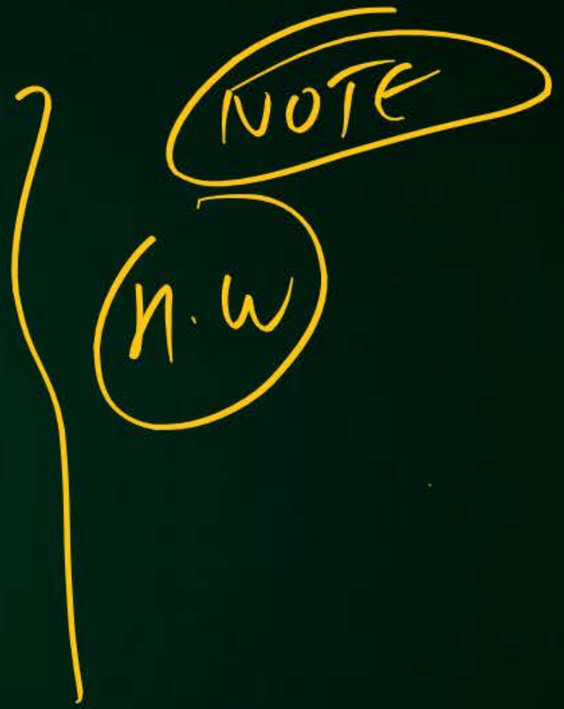
Classification H–Bonding



Intermolecular H-bonding	Intramolecular H-bonding
(i) Present b/w molecules	Present within molecule
(ii) Chelation (Ring) may occurs	Chelation always occurs (Ring Formation)
(iii) More association b/w molecules	Association b/w molecules is less
(iv) High M.P. & B.P.	Low M.P. & B.P.
(v) Less volatile (Low vapour pressure)	More volatile (Vapour pressure High)
(vi) Viscosity is more	Viscosity is less

Some Important points

1. Cellulose can show H-bonding with water.
2. Amino acid can show H-bonding with water
3. Water is liquid at room temp. while H_2S is gas.
4. Fire due to petrol can not be extinguish by water.
5. Fire due to alcohol can be extinguish by water.
6. Isomeric ethers are more volatile than alcohol.
7. High B.P. & viscosity can be explained by H-bonding.



Home work

True | False

1. $O_2^+ = O_2^-$ (Bond order)
2. $O_2^+ = O_2^-$ (Magnetic Moment)
3. $O_2 < N_2$ (ABMO e^-)
4. $O_2^+ < O_2^-$ (no. of unpaired e^-)
5. $N_2 < O_2$ (BMO e^-)
6. C_2 ($1\sigma + 1\pi$)
7. N_2 ($2\sigma + 1\pi$)
8. N_2^+ (Diamagnetic)
9. $N_2^+ = O_2^+$ (no. of Unpaired e^-)
10. $O_2^{2-} = O_2^+$ (no. of BMO e^-)

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  Offline (10:00 to 11:00 AM & 04:00 to 05:00 PM)
- **Exam Duration:** 60 Minutes

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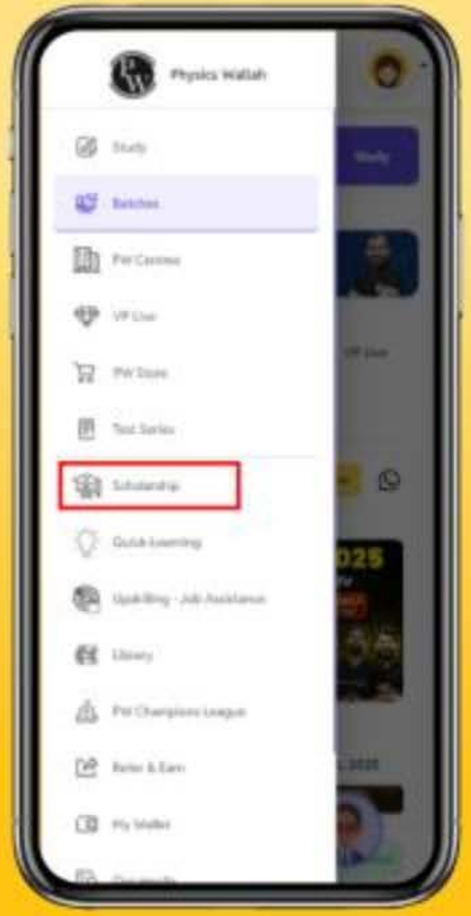

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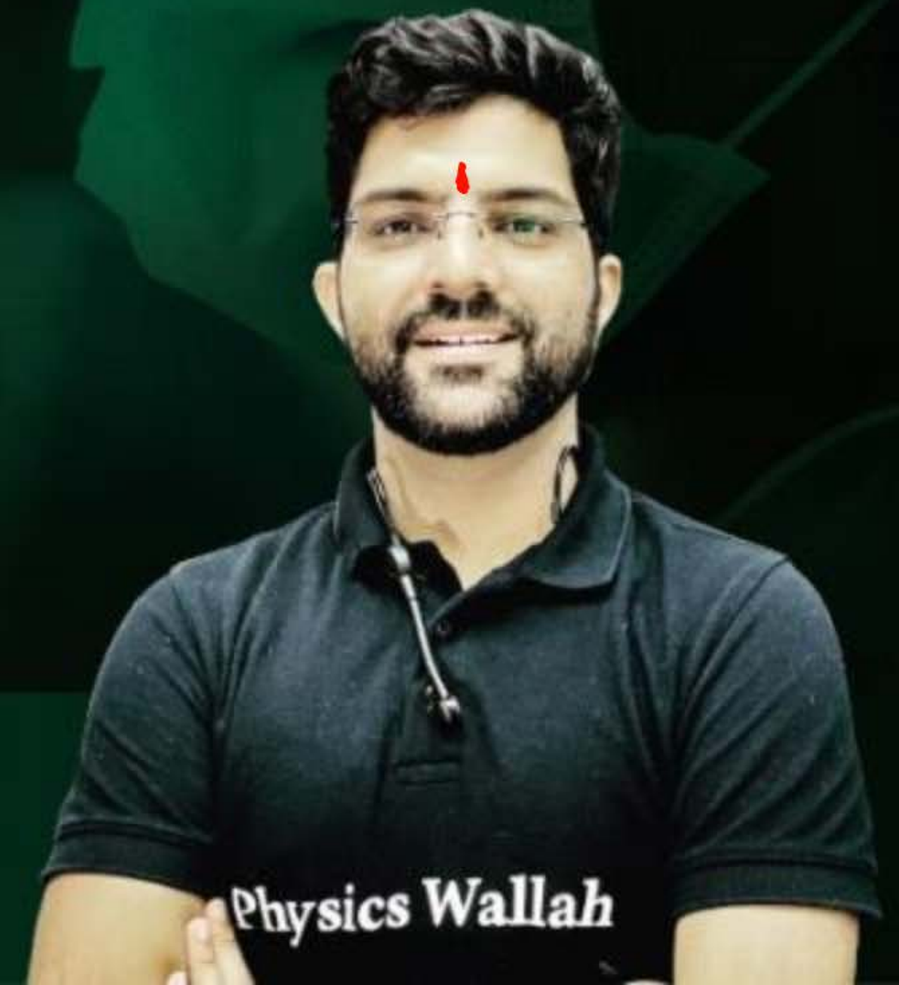
FOR NEET 2025

Lecture - 15 | Inorganic Chemistry

Chemical Bonding & Molecular Structure

By - Mohit Dadheech (MD Sir)



Topics *to be covered*

1. H-Bonding (Part-02)

Some Important points

No H-Bonding

H-Bonding (liquid)

1. Cellulose can show H-bonding with water. ✓
2. Amino acid can show H-bonding with water ✓
3. Water is liquid at room temp. while H_2S is gas. ✓
4. Fire due to petrol can not be extinguish by water. No H-Bonding b/w water & Petrol
5. Fire due to alcohol can be extinguish by water. H-Bonding b/w water & alcohol.
6. Isomeric ethers are more volatile than alcohol.

CH_3-O-CH_3 — H-Bonding ✗

C_2H_5-OH — H-Bonding ✓ less volatile.

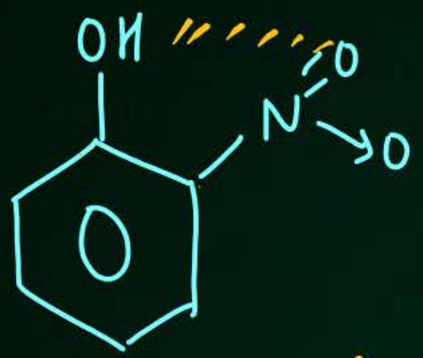
(M.F same)

7. (A) High B.P. & viscosity can be explained by H-bonding.

(B) High surface tension of water can be explained by H-bonding.

Imp

8. Ortho-Nitrophenol is more volatile than para-nitrophenol.



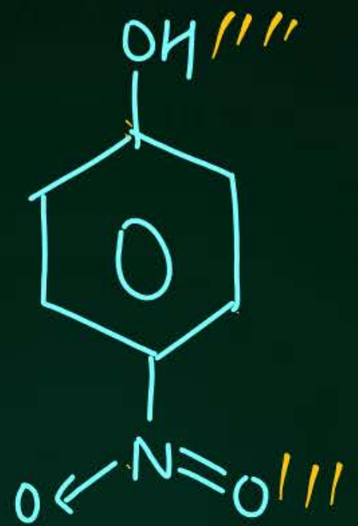
O-Nitrophenol

Intramolecular

less association

More volatile

less B.P



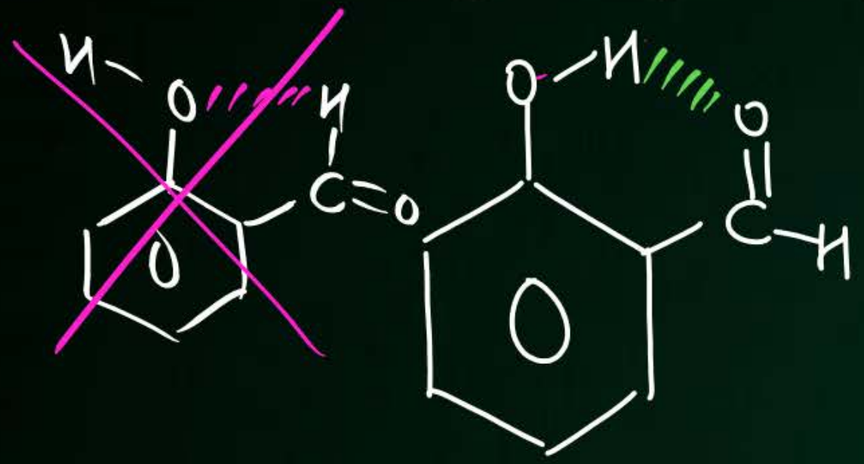
Inter molecular H-Bonding

More association b/w Molecules.

less Volatile.

More B.P

9. Ortho-Salicylaldehyde is liquid at room temp. while para-salicylaldehyde is solid.



Intra.

less association

liquid at room temp

Inter

More association

Solid at room temp

V.Imp

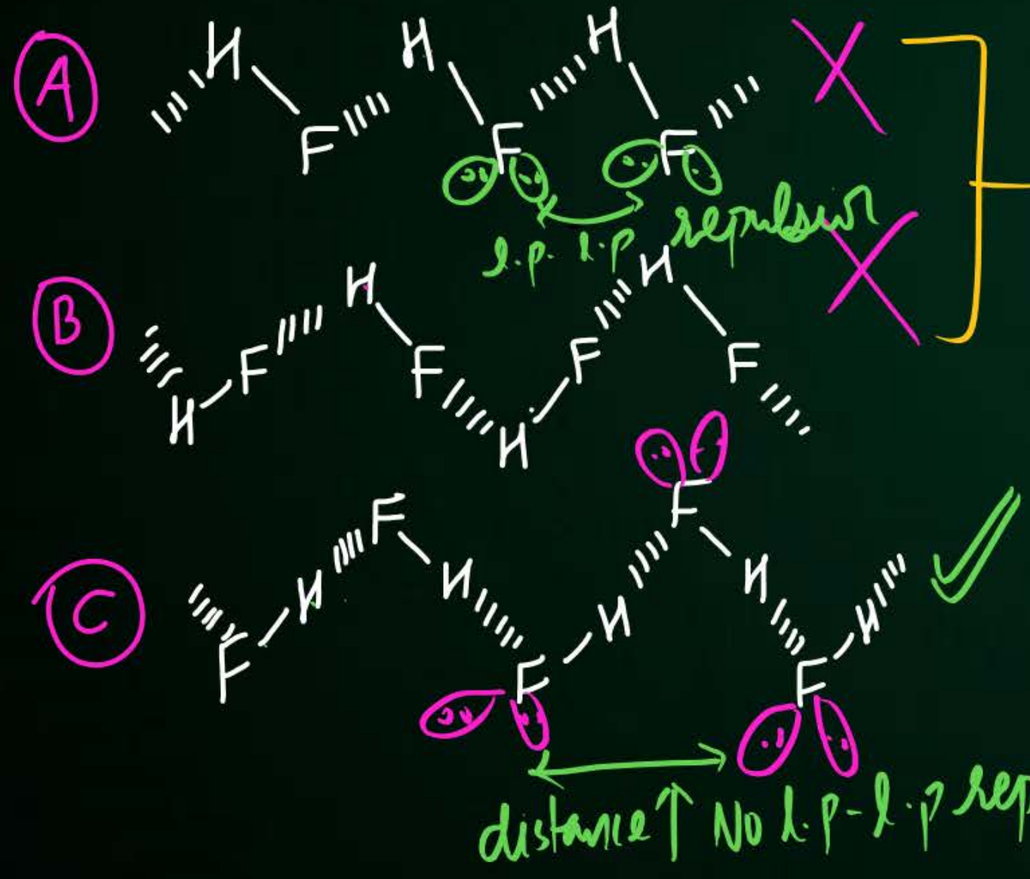
H-Bonding between HF Molecules :-

→ Strongest H-Bonding.

→ M.P & B.P is Higher than Expecations due to H-Bonding

* Zig-Zag Patkern

Intermolecular



Reasons

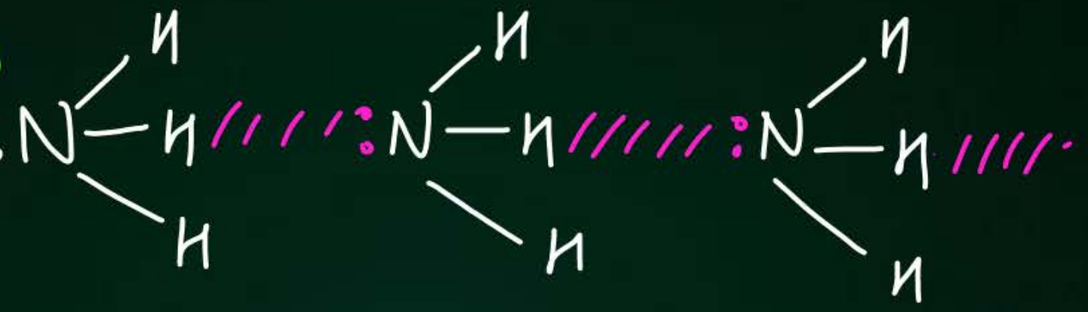
(i) H can not be present at Corner due to absence of l.p

(ii) l.p l.p Repulsion is High b/w F-F

H-Bonding in NH_3 :—

Intermolecular

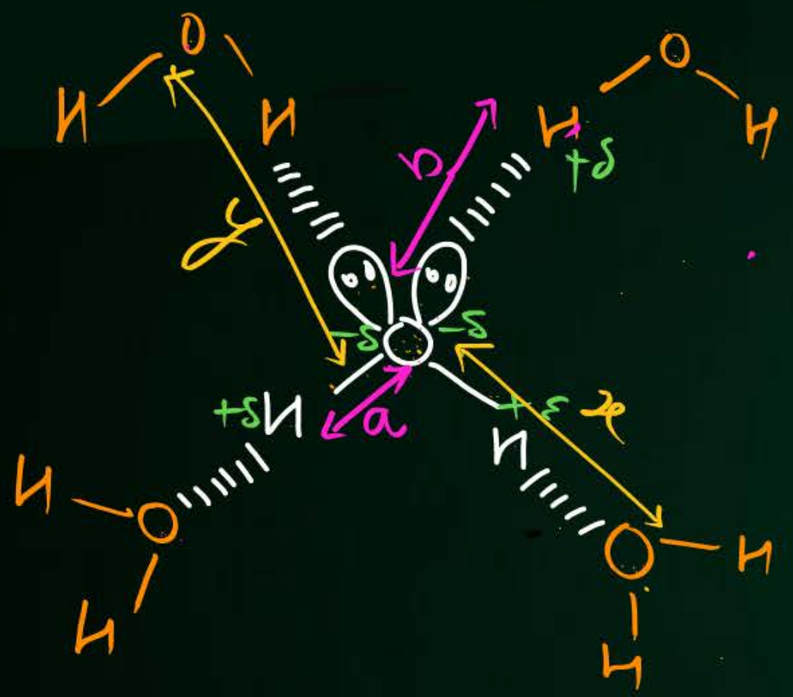
Avg no. of H-Bond in NH_3 = 2 (Bond Per Molecule)



* Closedpacking (Pyramidal) ✓

* due to H-Bonding M.P & B.P of NH_3 is Higher than Expectation among Other Hydrides of group 15th.

H-Bonding in $H_2O_{(s)}$ (Ice)



* Four sites involved in H-Bonding
* 3D H-Bonding (Intermolecular)
* Cage like structure (tetrahedral Void) (Khali Space)

due to Void Volume ↑se ∴ density ↓se in ice

on Heating Ice Contracts

↓

Volume ↓ Density ↑se

$\therefore d_{water} > d_{ice}$ (Ice floats on water)

* Oxygen of Central molecule :-
  (i) Surrounded by Four equidistant "H" ⇒ False ∵ $a < b$
  (ii) —"— —"— —"— —"— Oxygen True ($\because x = y$)

$H_2O_{(s)}$ Floats on $H_2O_{(l)}$ (T)

$D_2O_{(s)}$ Floats on $D_2O_{(l)}$ (T)

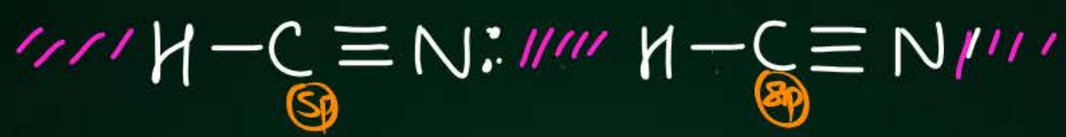
$D_2O_{(s)}$ Floats on $H_2O_{(l)}$ (F)

$H_2O_{(s)}$ Floats on $D_2O_{(l)}$ (T)

H-Bonding in HCN

linear

Intermolecular



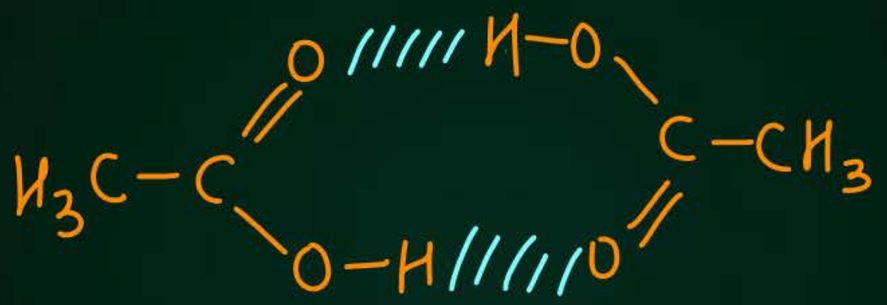
C_{sp} Hybridised EN = 3.25

In HCN, "H" is attached to C_{sp} Can show H-Bonding.

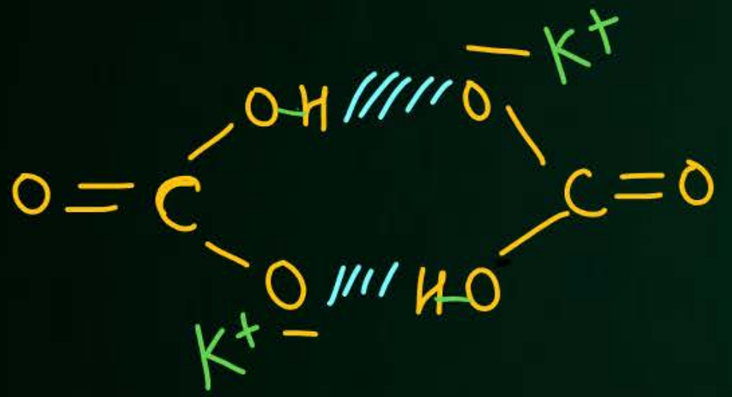
Dimer formation of CH_3COOH into Nonpolar solvent like Benzene

Reason- H-Bonding.

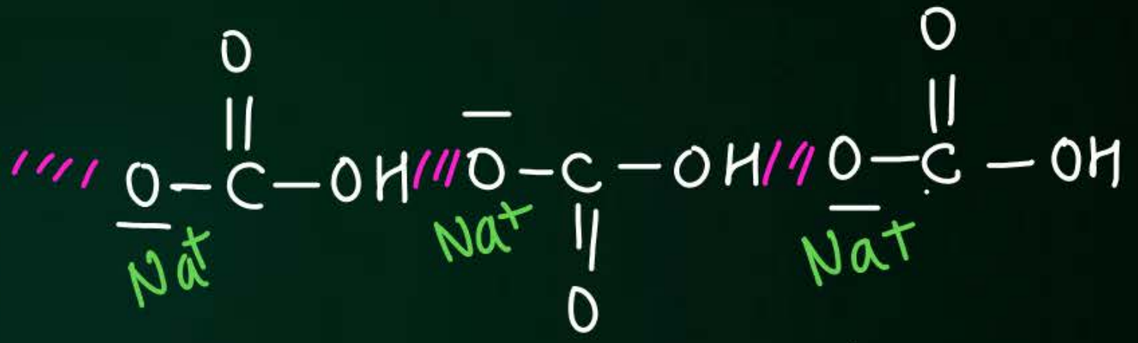
Inter Molecular



HCO_3^- (Bicarbonate ion) in $NaHCO_{3(s)}$ is present in polymeric form while in $KHCO_{3(s)}$ it can form only dimer.



In the Lattice of $KHCO_{3(s)}$ due to large size of K^+ ions HCO_3^- ions are far from each other. So it can form dimer only.



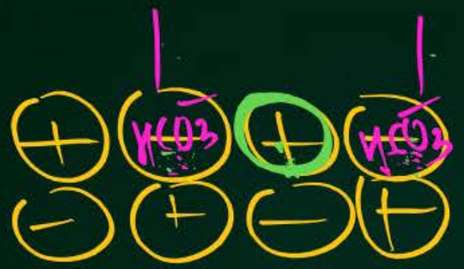
due to small size of Na^+ ions HCO_3^- ions are more closer to each other & polymerise easily.

(5) Lattice

K^+ } HCO_3^- ✓

Na^+ } HCO_3^- ✓

Ionic



$Na^+ < K^+$ (Size)

Strength & Extent of H-Bonding

Strength of H-Bond → Bond Energy of one H-Bond.

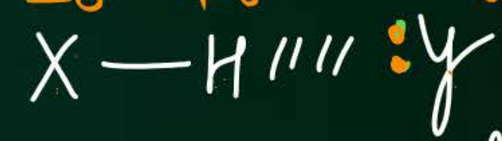
Extent of H-Bonding → number of H-Bonds per molecule.
(No. of sites)

Conditions For Stronger H-Bonding :—

(1.) Strongest H-Bonding ⇒ HF Molecules.

//// H—F //// H—F ////

(2.) For other Cases



↳ EN of X should be High

→ If X is same then EN of Y should be Low.

(More easy donation of l.p)

order of strength.

Ex $HF > H_2O > NH_3$

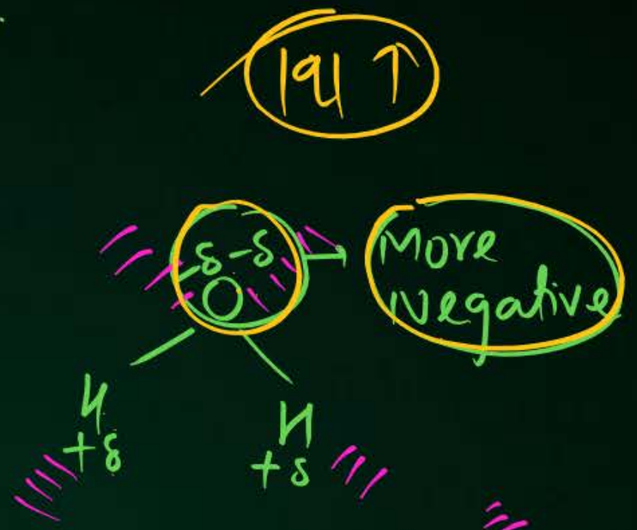
$H_2O > H_2O_2$

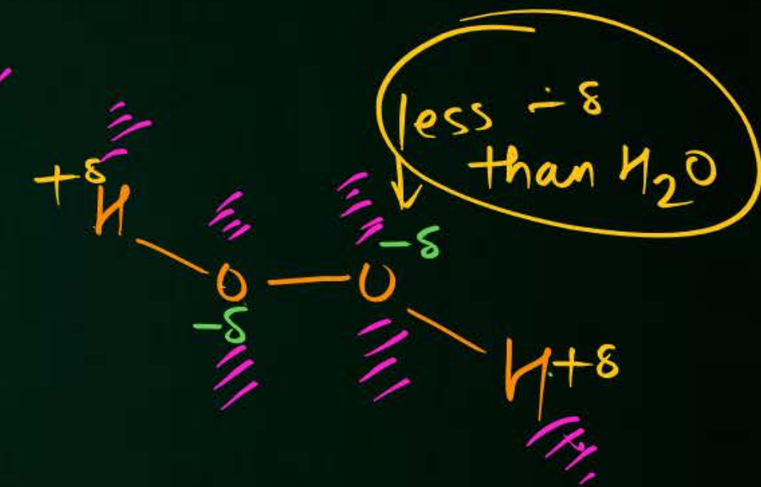
(EN of X) $O-H\cdots O > N-H\cdots N$

(X same) $N-H\cdots N > N-H\cdots O > N-H\cdots F$

Y EN↓ strength↑

$H_2O < D_2O < T_2O$





But

Extent

$H_2O < H_2O_2$

4 sites

6 sites

Order of B.P. & M.P. in group 15, 16, 17 hydrides

- M.P. & B.P. of group 15, 16 and 17 hydrides is mainly depends on weak Vander Waal force (W.V.F $\propto$ molecular weight) but M.P. & B.P. of NH_3, H_2O and HF is higher than expectation in their respective group due to presence of H-bonding.

BP

MD'J 2, 1, 1

Top to Bottom

NH_3 (2)	H_2O (1)	HF (1)
PH_3 4	H_2S 4	HCl 4
AsH_3 3	H_2Se 3	HBr 3
SbH_3 1	H_2Te 2	HI 2

according to M.W

(W.V.f ∝ M.W)

1 > 2 > 3 > 4

MP

MD'J 1 1 2

Top to Bottom

NH_3 (1)	H_2O (1)	HF (2)
4 PH_3	4 H_2S	4 HCl
3 AsH_3	3 H_2Se	3 HBr
2 SbH_3	2 H_2Te	1 HI

Strength of H-Bond

$HF > H_2O > NH_3$

Boiling Point order

$H_2O > HF > NH_3$

Melting Point order

$H_2O > NH_3 > HF$

NH_3 has More Close Packing in Solid

HF has Low Packing efficiency due to Zig-Zag

Voids are Large

QUESTION

The crystal lattice of ice is mostly formed by :

1. Ionic forces
2. Covalent bonds
3. Intra molecular H-bonds
4. Covalent as well as H-bonds

QUESTION

Intramolecular H-bond :

1. Decreases volatility
2. Increases melting point
3. Increases viscosity
4. None of these

QUESTION

Which of the following hydrides has the lowest B.P. -

1. H_2O
2. H_2S
3. H_2Se
4. H_2Te

QUESTION

The correct order of strength of H-bond in the following compound :

1. $H_2O > H_2O_2 > HF > H_2S$
2. $HF > H_2O_2 > H_2O > H_2S$
3. $HF > H_2O > H_2S > H_2O_2$
4. $HF > H_2O > H_2O_2 > H_2S$

Homework

Module - 1

Questions Based on

MOT & H-Bonding.

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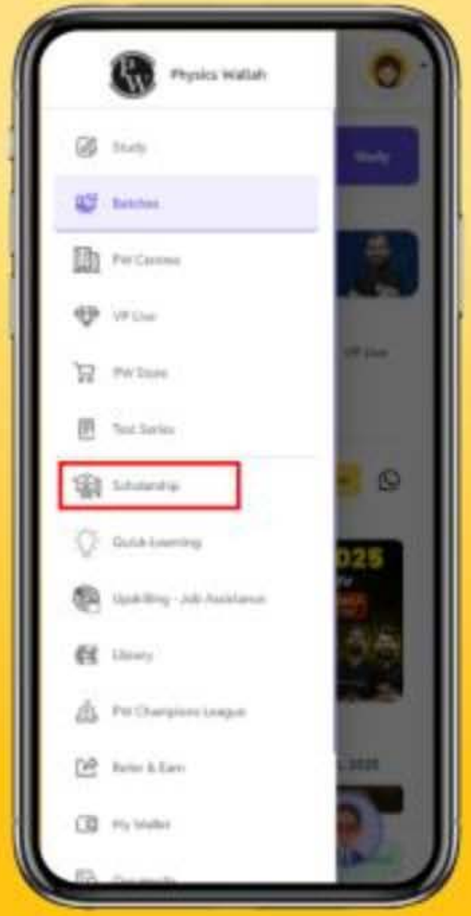

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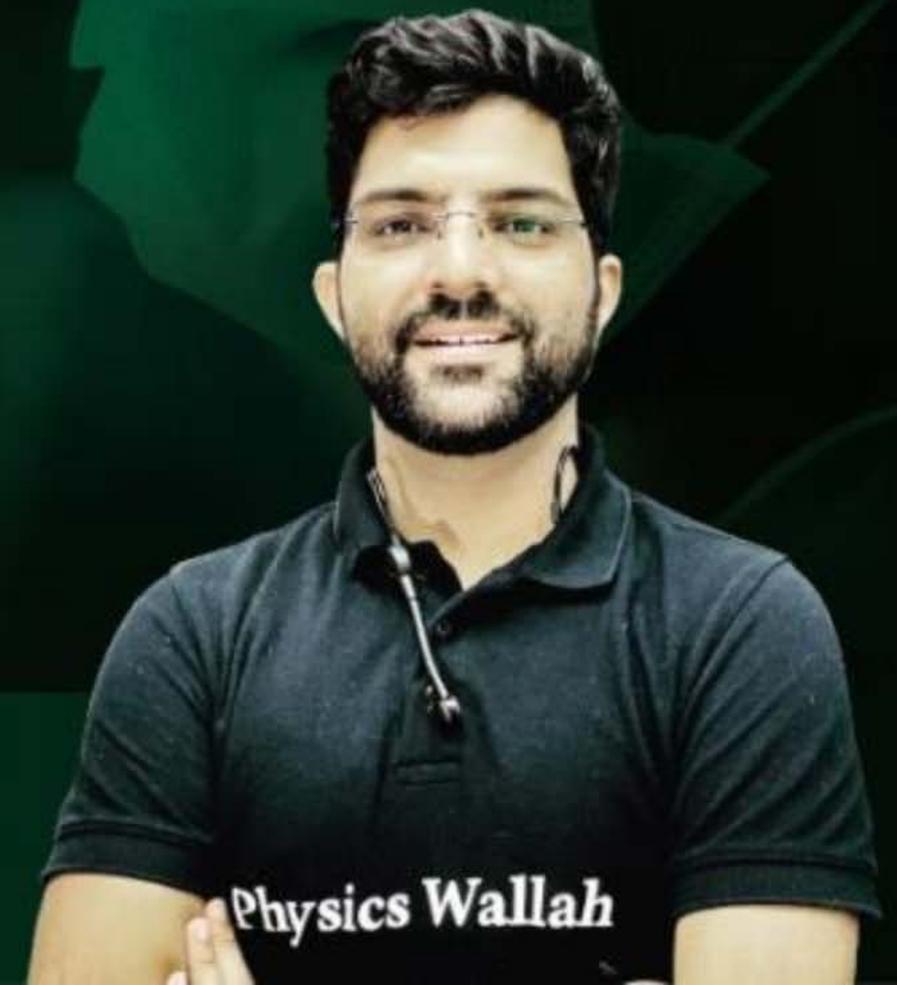
FOR NEET 2025

Lecture - 16 | Inorganic Chemistry

Chemical Bonding & Molecular Structure



By - Mohit Dadheech (MD Sir)

Topics *to be covered*

1. Dipole Based Forces
2. NCERT Scrutinizing

[Top to bottom]

15th	16th	17th
NH_3	H_2O	HF
PH_3	H_2S	HCl
AsH_3	H_2Se	HBr
SbH_3	H_2Te	HI

E-H Bond length ↑se

E-H Bond strength ↓se

E-H Bond dissociation Enthalpy ↓se

H^+ donation tendency in aq. medium ↑se

↳ Acidic Nature ↑se

⇒ H removal tendency ↑se
(oxidation tendency ↑se)

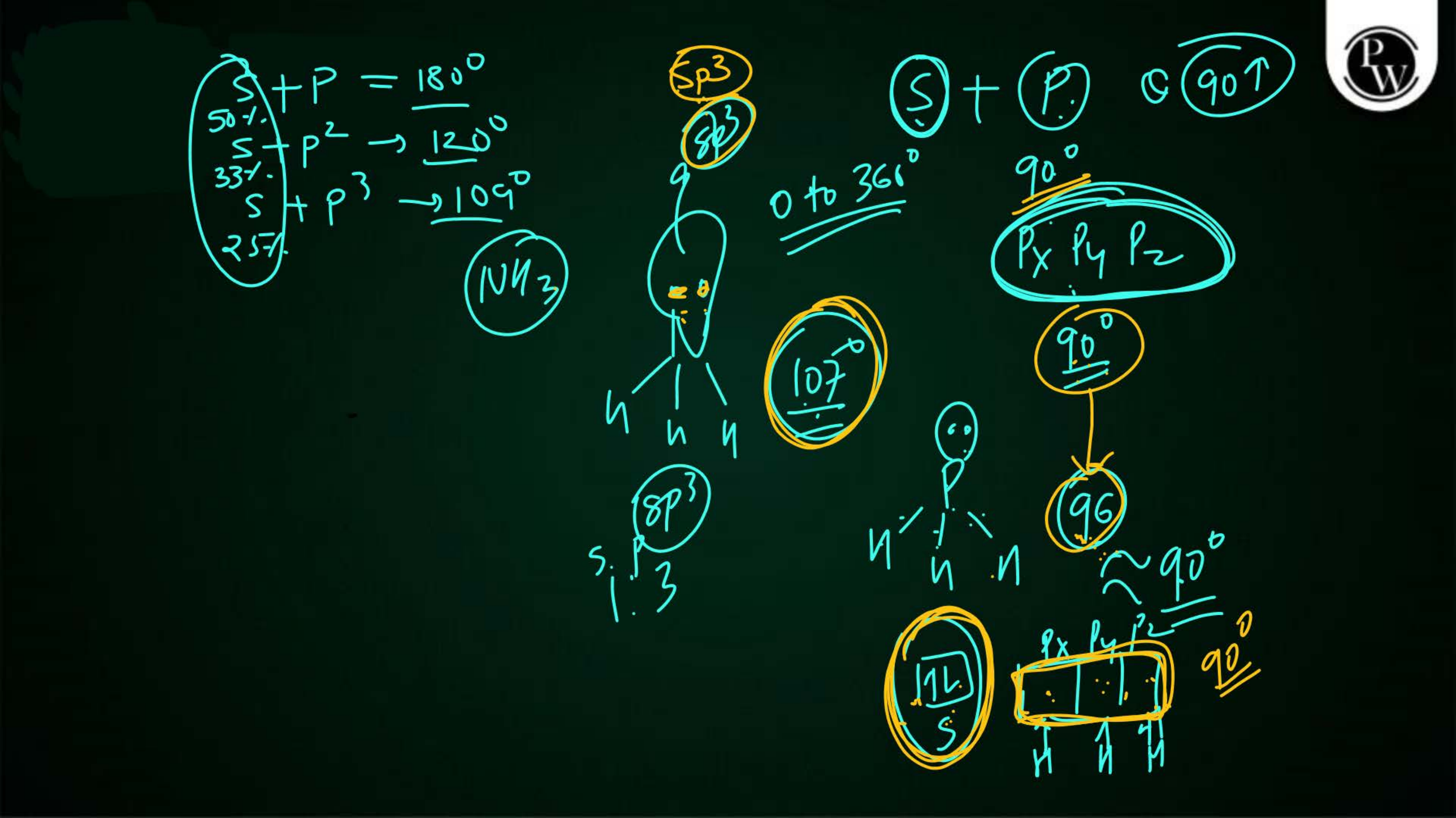
↳ Reducing Nature ↑se.

Only For 15th & 16th

Bond Angle → ↓se

Lewis basic Nature → ↓se

L.P directional nature → ↓se


s + p = 180°
50%
s + p² → 120°
33%
s + p³ → 109°
25%
NH3
sp3
sp3
0 to 361°
107°
8p3
s. p
1. 3
s + p. ⊙ 90↑
90°
Px Py Pz
90°
96
~90°
~90°
90°
11L
s

Dipole based Forces

~~Vanderwaal Force~~

Ions involved

(1) Ion-dipole

Resposible For association b/w ions & Polar Mole

(2) Ion-Induced dipole

Responsible For association b/w ions & Non polar species.

Strength order :

1 > A > 2 > B > C

Vanderwaal Forces

Ions not involved

(A) Dipole-dipole (Keesom Force)

Resp. Association b/w Polar molecules.

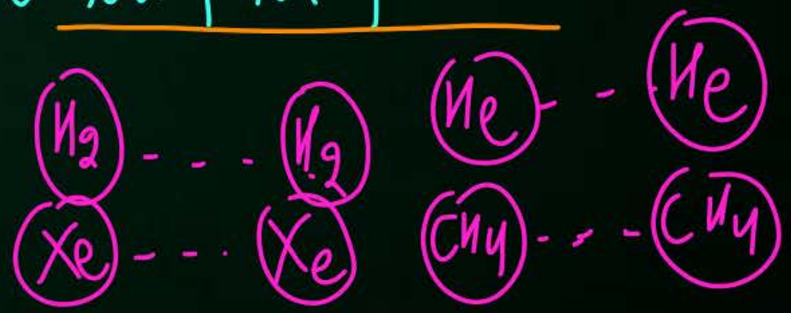
(B) Dipole-induced dipole (Debye)

Resp. Association b/w Polar & Non polar Molecules.

(C) Instantaneous dipole-induced dipole (Landon dispersion force)

Responsible → Association b/w Non polar species.

→ Weakest Bond.



Relation of Force & Interaction energy

Strength $1 > A > 2 > B > C$

Force

$F \propto \frac{1}{r^3}$ ID

$\propto \frac{1}{r^4}$ DD

$\propto \frac{1}{r^5}$ IID

$\propto \frac{1}{r^7}$ DLD

$\propto \frac{1}{r^7}$ IDID

3, 4, 5, 7 7

$E \propto \frac{1}{r^2}$

$\propto \frac{1}{r^3}$ In solid state

$\propto \frac{1}{r^4}$

$\propto \frac{1}{r^6}$

$\propto \frac{1}{r^6}$

liquid $E \propto \frac{1}{r^6}$

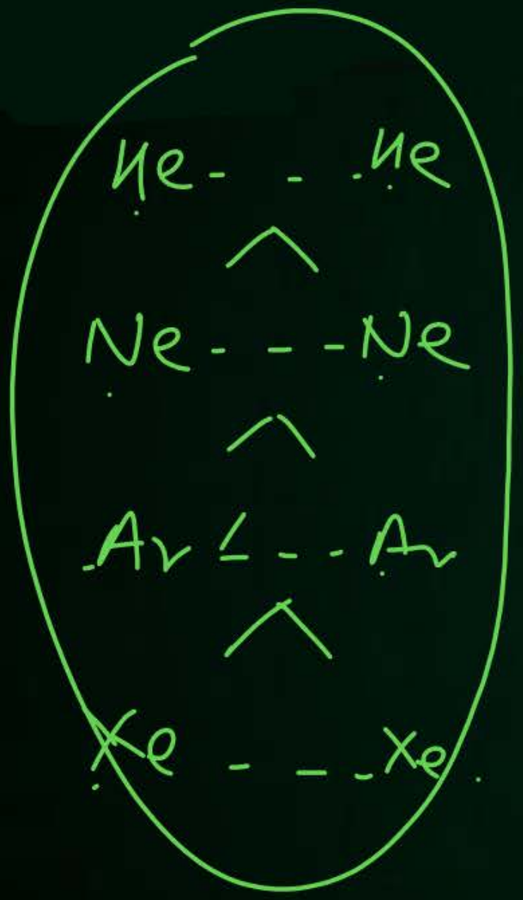
Type of Interactions present b/w Following Species :—

1. CH_4 --- CH_4 LDF
2. He --- He LDF
3. SnH_4 --- SnH_4 LDF
4. Xe --- Xe LDF
5. Li^+ --- H_2O ID
6. Na^+ --- H_2O ID
7. HCl --- HCl DD
8. Na^+ --- Br_2 ITD
9. Na^+_I --- $CS_{2\,NP}$ ITD
10. H_2O_P --- $Br_{2\,NP}$ DID
11. Br_2 --- Br_2 LDF
12. Cl_2 --- Cl_2 LDF
13. Na^+ --- Cl^- (Ionic Bond)
14. HF --- HF (Hydrogen Bond)
15. $CCl_{4\,NP}$ --- $CCl_{4\,NP}$ LDF
16. H_2S_P --- H_2S_P DD
17. NH_3 --- NH_3 (H-Bonding)
18. H_2O --- H_2O (H-Bonding)

Some Imp Points

* W.V.f $\propto$ M.W
* Responsible For Molecular Interactions.
  (atomic in Case of Noble gases)
* W.V.f also depend on physical state.
  S > L > G Gen

Imp. Properties of Inert gases Top to Bottom :-

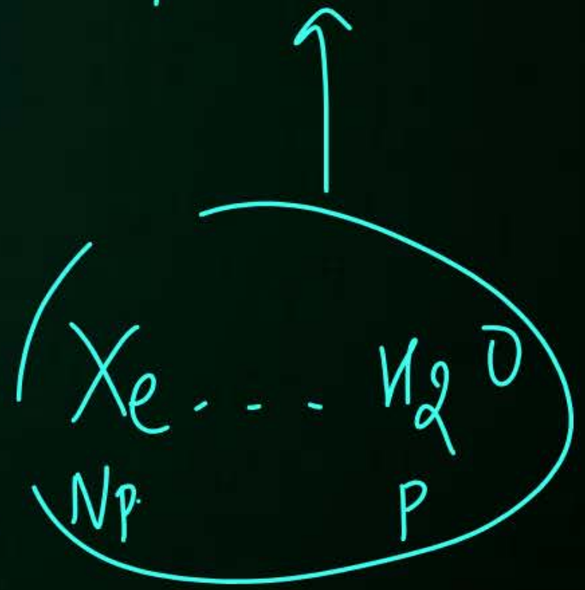


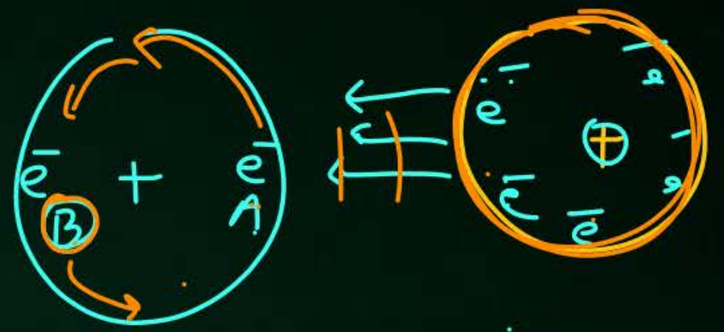
He
Ne
Ar
Kr
Xe ↓

* Size ↑ → Surface area ↑
* I.E ↓
* M.W ↑
* W.V.f ↑

] M.W ↑, LDF ↑, DID ↑

* Solubility in water ↑se] decided by DID
* Real character ↑se
* Ideal character ↓se.
* Surface area ↑se.
* Adsorption tendency on charcoal Surface ↑se
* M.P ↑se
* B.P ↑se.

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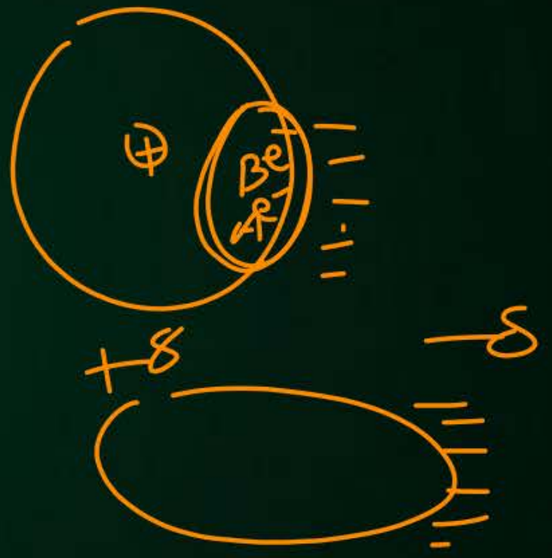

Be
+8
-8

QUESTION

The incorrect order of decreasing boiling points is :

1. $NH_3 > AsH_3 > PH_3$
2. $H_2O > H_2Se > H_2S$
3. $Br_2 > Cl_2 > F_2$
4. $CH_4 > GeH_4 > SiH_4$

NCERT KI CHOTI CHOTI MAGAR MOTI BAATEIN

VSEPR

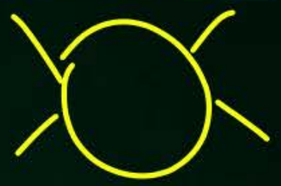
- The shape of a molecule depends upon the number of valence shell electron pairs (bonded or nonbonded) around the central atom.

$\sigma + l \cdot p$

- Pairs of electrons in the valence shell repel one another since their electron clouds are negatively charged.

- These pairs of electrons tend to occupy such positions in space that minimise repulsion and thus maximise distance between them.

- The valence shell is taken as a sphere with the electron pairs localising on the spherical surface at maximum distance from one another.



- A multiple bond is treated as if it is a single electron pair and the two or three electron pairs of a multiple bond are treated as a single super pair.

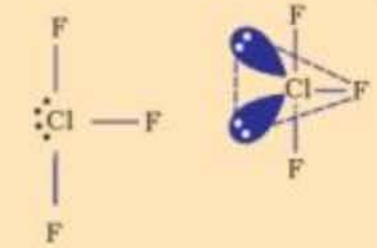
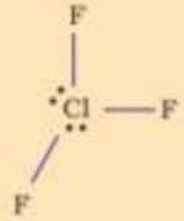
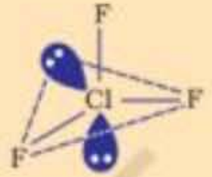
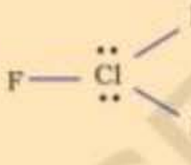
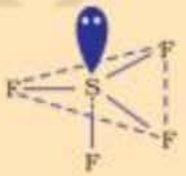
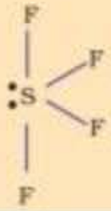
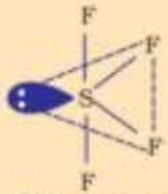
- Where two or more resonance structures can represent a molecule, the VSEPR model is applicable to any such structure.

- While the lone pairs are localised on the central atom, each bonded pair is shared between two atoms.

- As a result, the lone pair electrons in a molecule occupy more space as compared to the bonding pairs of electrons.

- This results in greater repulsion between lone pairs of electrons as compared to the lone pair - bond pair and bond pair - bond pair repulsions.

$l.p - l.p > l.p - b.p > b.p - b.p$

Molecule type	No. of bonding pairs	No. of lone pairs	Arrangement of electrons	Shape	Reason for the shape acquired
AB_3E_2	3	2	(a) 	T-shape	In (a) the lp are at equatorial position so there are less lp-bp repulsions as compared to others in which the lp are at axial positions. So structure (a) is most stable. (T-shaped).
			(b)  		
			(c) 		
AB_4E	4	1	(a) 	See-saw	In (a) the lp is present at axial position so there are three lp—bp repulsions at 90°. In(b) the lp is in an equatorial position, and there are two lp—bp repulsions. Hence, arrangement (b) is more stable. The shape shown in (b) is described as a distorted tetrahedron, a folded square or a see-saw.
			(b)   (More stable)		

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NOTES

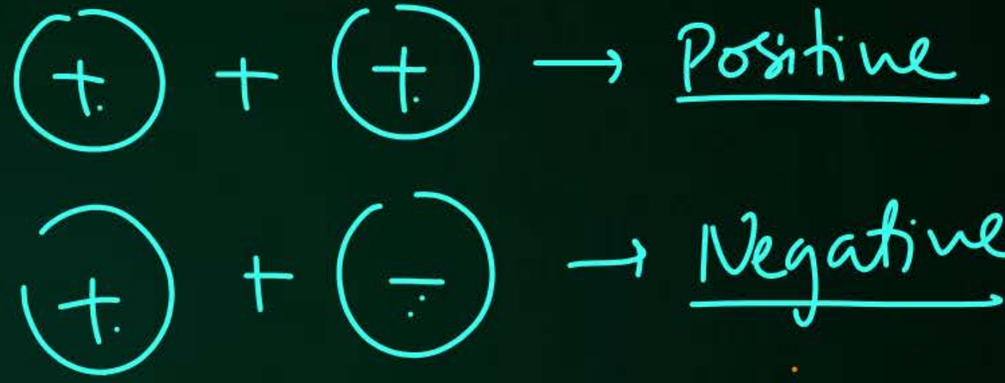
Formal charge

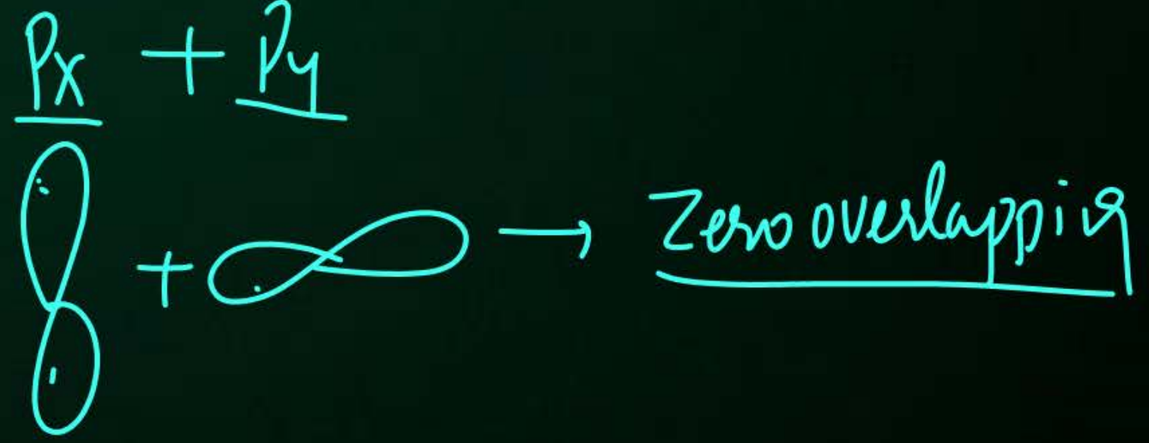
- Generally the lowest energy structure is the one with the smallest formal charges on the atoms. The formal charge is a factor based on a pure covalent view of bonding in which electron pairs are shared equally by neighbouring atoms.

(Overlapping)

- According to orbital overlap concept, the formation of a covalent bond between two atoms results by pairing of electrons present in the valence shell having opposite spins.

- Orbitals of two atoms come close to form bond, their overlap may be positive, negative or zero depending upon the sign (phase) and direction of orientation of amplitude of orbital wave function in space.





- Orbitals forming bond should have same sign (phase) and orientation in space. This is called positive overlap.

→ Positive

$p_x + p_x$ ✓

$p_x + p_y$ ✗

$p_z + p_z$ ✓

$p_z + p_x$ ✗

- The strength of a bond depends upon the extent of overlapping. In case of sigma bond, the overlapping of orbitals takes place to a larger extent. Hence, it is stronger as compared to the pi bond where the extent of overlapping occurs to a smaller extent. Further, it is important to note that in the formation of multiple bonds between two atoms of a molecule, pi bond(s) is formed in addition to a sigma bond.

Head on

B.S & Merging area

Collateral

Head on > Collateral

$\sigma > \pi$

(Hybridisation)

- [redacted] the atomic orbitals combine to form new set of equivalent orbitals known as hybrid orbitals. Unlike pure orbitals, the hybrid orbitals are used in bond formation. The phenomenon is known as hybridisation which can be defined as the process of intermixing of the orbitals of slightly different energies so as to redistribute their energies, resulting in the formation of new set of orbitals of equivalent energies and shape.

- In the periodic table, the highly electronegative halogens and the highly electropositive alkali metals are separated by the noble gases.

- The formation of a negative ion from a halogen atom and a positive ion from an alkali metal atom is associated with the gain and loss of an electron by the respective atoms.

- The negative and positive ions thus formed attain stable noble gas electronic configurations. The noble gases (with the exception of helium which has a duplet of electrons) have a particularly stable outer shell configuration of eight (octet) electrons, ns^2np^6.

- The negative and positive ions are stabilized by electrostatic attraction.

- The Small the size of the cation and the Large the size of the anion, the greater the covalent character of an ionic bond.

- The greater the charge on the cation, the greater the Covalent character of the ionic bond.

- Obviously ionic bonds will be formed more easily between elements with comparatively low ionization enthalpies and elements with comparatively high negative value of electron gain enthalpy.

H-Bonding

- Hydrogen bond can be defined as the attractive force which binds hydrogen atom of one molecule with the High EN atom of another molecule.

MOT

- Oxygen molecule contains two unpaired electrons in _____ molecular orbitals.

π^*2p_x & π^*2p_y or π ABMO

- Double bond in C_2 consists of both π bonds because of the presence of four electrons in two π BMO molecular orbitals.

($\pi 2p_x$ & $\pi 2p_y$)

- The molecule is stable if N_b is greater than N_a, and the molecule is unstable if N_b is less than N_a.

BMO e^- ABMO e^-

- If all the molecular orbitals in a molecule are doubly occupied, the substance is diamagnetic.

$n=0$

- If one or more molecular orbitals are singly occupied it is Paramagnetic

1 e^-

2|2|

- For B_2, C_2, N_2 energy of $\sigma 2p_z$ molecular orbital is greater than that of $\pi 2p_x$ and $\pi 2p_y$ molecular orbitals.

$\pi 2p_x$, $\pi 2p_y$ < $\sigma 2p_z$

- In the formation of bonding molecular orbital, the two electron waves of the bonding atoms reinforce each other due to _____ interference.

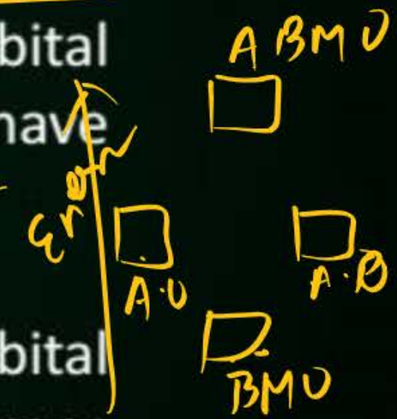
(Constructive)

- The electron density in a bonding molecular orbital is located between the nuclei of the bonded atoms because of which the repulsion between the nuclei is very less while in case of an antibonding molecular orbital, most of the electron density is located away from the space between the nuclei.

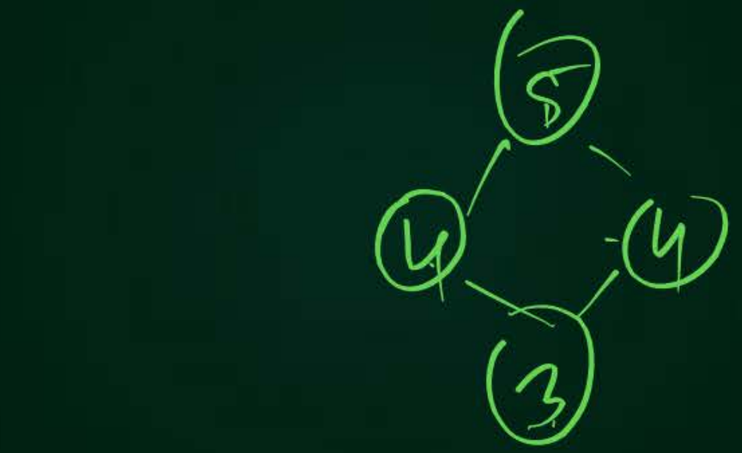
- Infact, there is a nodal plane (on which the electron density is zero) between the nuclei and hence the repulsion between the nuclei is high.

- Electrons placed in a bonding molecular orbital tend to hold the nuclei together and stabilise a molecule. Therefore, a bonding molecular orbital always possesses lower energy than either of the atomic orbitals that have combined to form it.

- In contrast, the electrons placed in the antibonding molecular orbital destabilise the molecule. This is because the mutual repulsion of the electrons in this orbital is more than the attraction between the electrons and the nuclei, which causes a net increase in energy.



- The energy of the antibonding orbital is raised above the energy of the parent atomic orbitals that have combined and the energy of the bonding orbital has been lowered than the parent orbitals. The total energy of two molecular orbitals, however, remains the same as that of two original atomic orbitals.



Total Energy = 8

- The combining atomic orbitals must have the same or nearly the same energy.

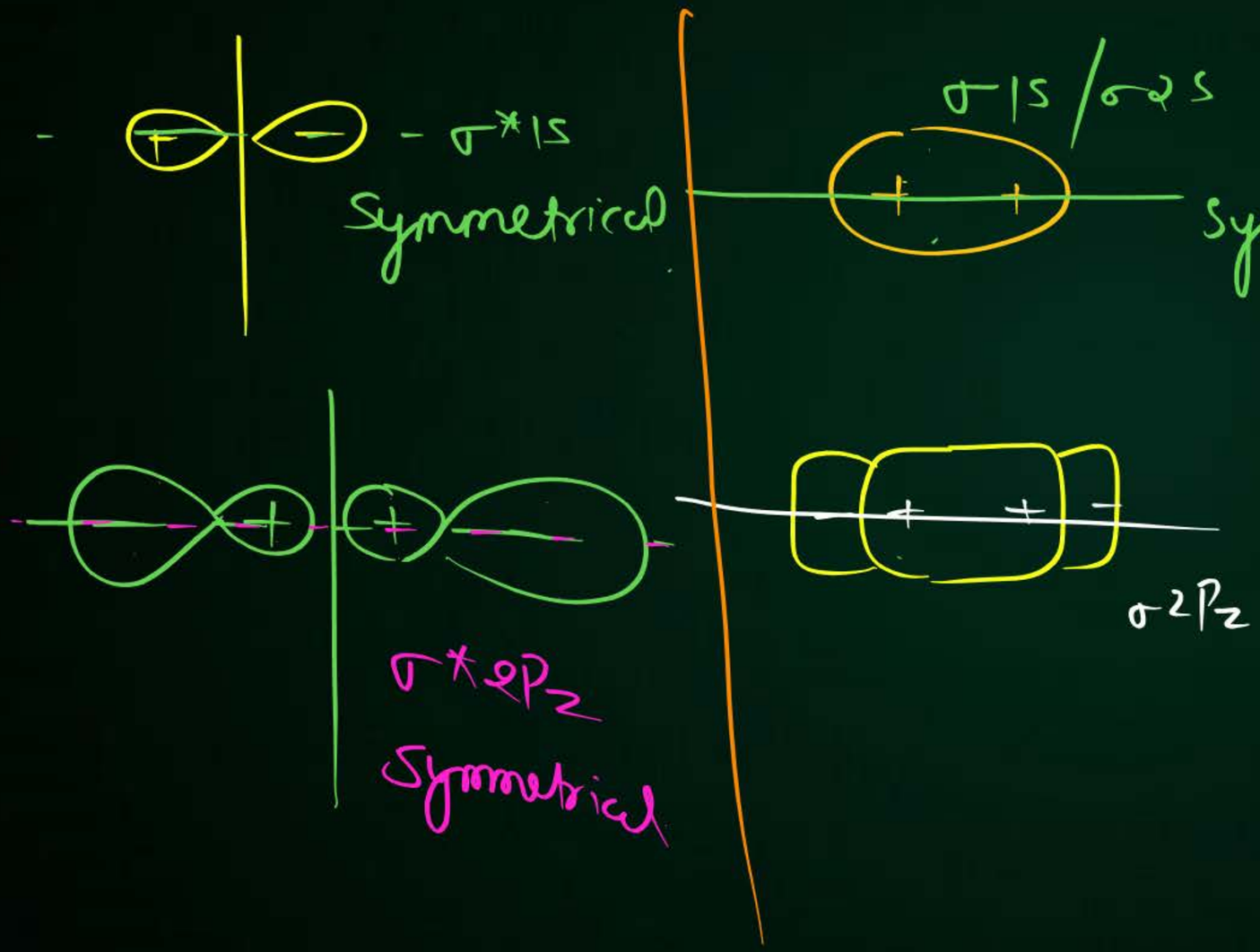
- The combining atomic orbitals must have the same symmetry about the molecular axis.

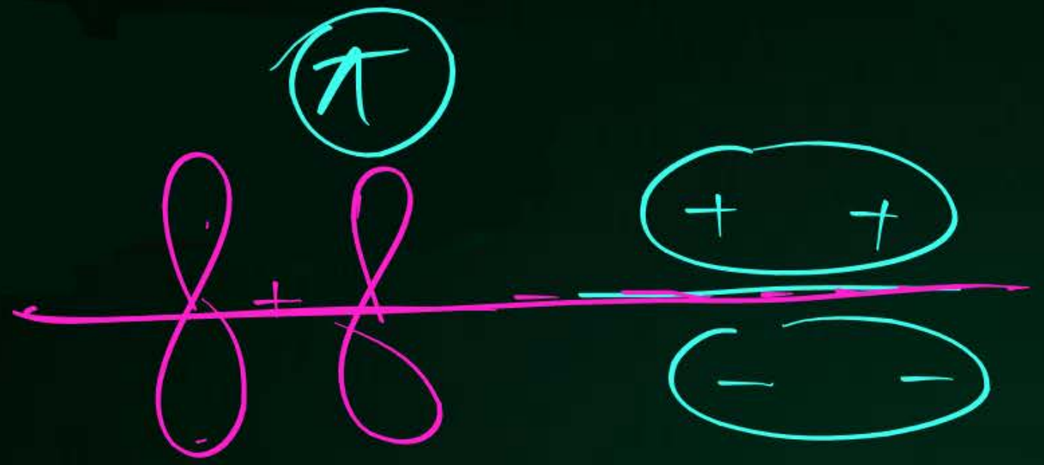
$p_x + p_x$ ✓

- The combining atomic orbitals must overlap to the maximum extent. ✓

- sigma (σ) molecular orbitals are symmetrical around the bond-axis while pi (π) molecular orbitals are not symmetrical.

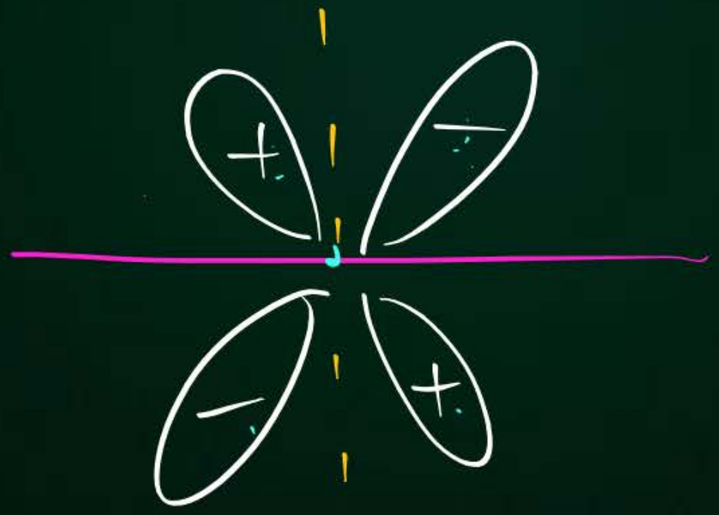
INA → According to NCERT (2)





$\pi 2p_x$ / $\pi 2p_y$

Unsymmetrical around Bond axis



$\pi^* 2p_x$ / $\pi^* 2p_y$

Unsymmetrical around Bond axis

- If internuclear axis is taken to be in the z-direction, it can be seen that a linear combination of $2p_z$ orbitals of two atoms also produces two sigma molecular orbitals designated as $\sigma 2p_z$ and $\sigma^* 2p_z$.

- Molecular orbitals obtained from $2p_x$ and $2p_y$ orbitals are not symmetrical around the bond axis because of the presence of positive lobes above and negative lobes below the molecular plane. Such molecular orbitals, are labelled as π and = π^*. A π bonding MO has larger electron density above and below the inter-nuclear axis. The π^* antibonding MO has a node between the nuclei.

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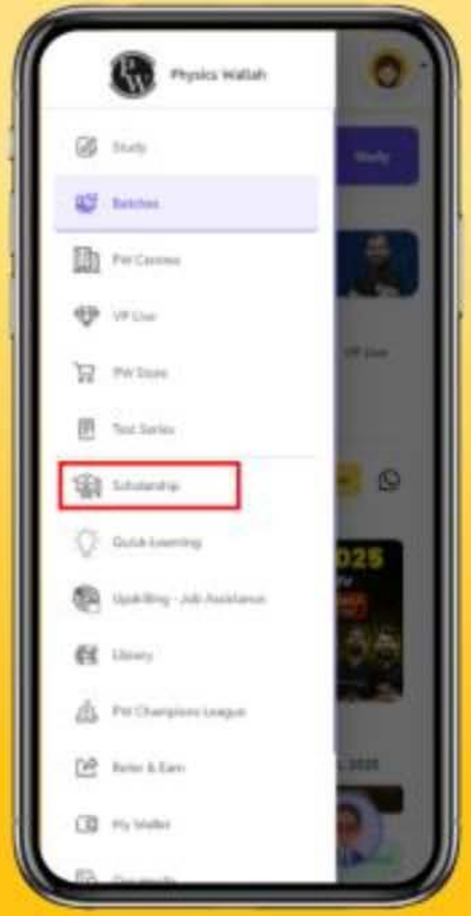

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Cohort	Class	Name of the Test	Exam Date	Mode	Physics	Chemistry	Botany	Zoology
NEET	11	Test 1	13-Oct-2024	Online	Basic Maths & Calculus (Mathematical Tools) Vectors Units and Measurements Motion in a straight line	Structure of Atom Some Basic Concepts of Chemistry Classification of Elements and Periodicity in Properties	Cell - The Unit of Life Cell Cycle and Cell Division	Structural Organization in Animals Breathing and Exchange of Gases

12th NEET REAL TEST SERIES SYLLABUS

Cohort	Class	Name of the Test	Exam Date	Mode	Physics	Chemistry	Botany	Zoology
NEET	12	Test 1	13-Oct-2024	Online	Electric Charges and Fields Electrostatic Potential and Capacitance	Solution Electrochemistry	Sexual Reproduction in Flowering Plant	Human Reproduction

DROPPER NEET REAL TEST SERIES SYLLABUS

Cohort	Class	Name of the Test	Exam Date	Mode	Physics	Chemistry	Botany	Zoology
NEET	Dropper	Test 1	13-Oct-2024	Online	Basic Maths & Calculus (Mathematical Tools) Vectors Units and Measurements Motion in a straight line Motion in a plane Circular motion Laws of motion	Some Basic Concept of Chemistry Redox Reaction Solutions Thermodynamics Equilibrium Electrochemistry	Cell - The Unit of Life Cell Cycle and Cell Division The Living World Biological Classification Plant Kingdom Morphology of Flowering Plants	Structural Organization in Animals Breathing and Exchange of Gases Body Fluids and Circulation Excretory Products & their Elimination

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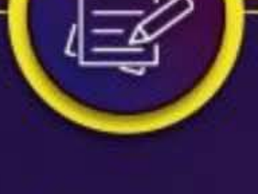

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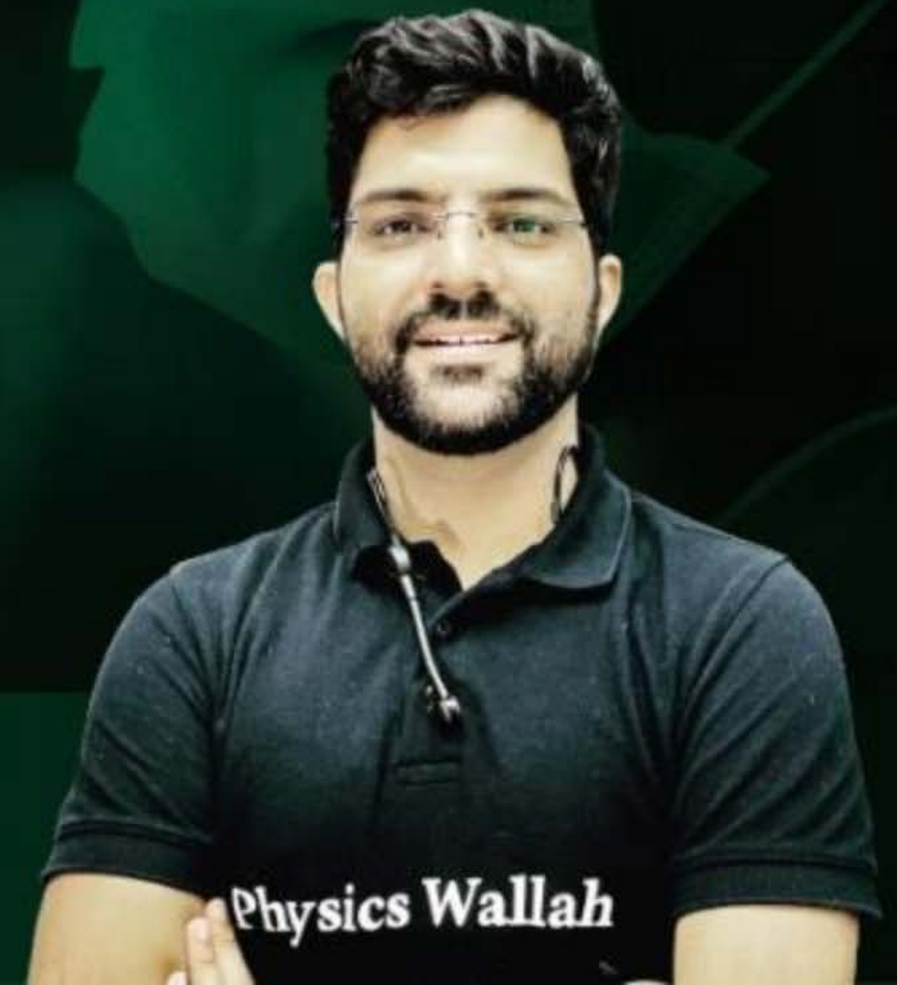
Lecture - 17 | Inorganic Chemistry

Chemical Bonding & Molecular Structure

By - Mohit Dadheech (MD Sir)



Topics *to be covered*

1. Practice Questions

QUESTION

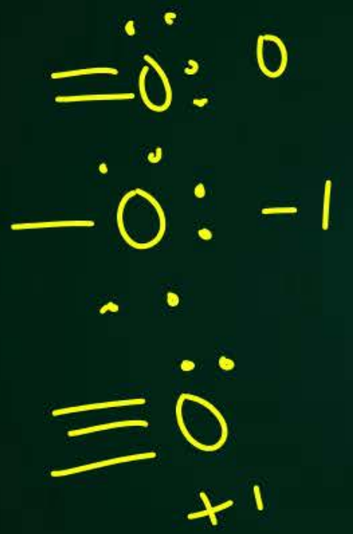
Which of the following Lewis dot structure of CO_2 is incorrect ?

1. :Ö – C ≡ O:

2. Ö = C = Ö

3. :O ≡ C – Ö:

4. None of these



QUESTION

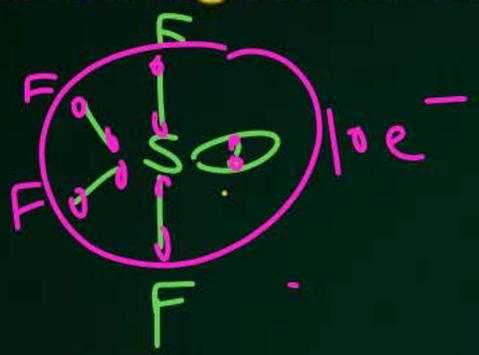
According to Lewis dot structure the number of bond pairs around central atom is greater than four for which of the following anion?

1. CO_3^{2-}
2. NO_3^-
3. PO_4^{3-}
4. None

QUESTION

Which of the following follow octet rule ?

1. SF_4
2. AlF_3
3. Boric acid
4. BCl_3

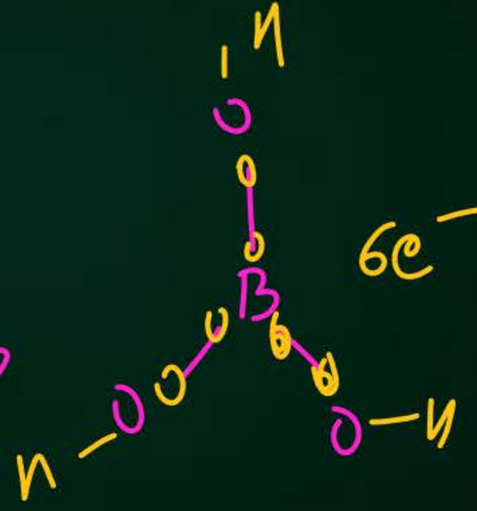


AlF_3 Ionic

Al^{3+} F^-

8e⁻ 8e⁻

$B(OH)_3$ or H_3BO_3



6e⁻

QUESTION

In which of the following species the bonds are non directional ?

Ionic

1. NCl_3 · sp^3
2. RbCl · Ionic ✓
3. $BeCl_2$ · sp
4. BCl_3 · sp^2

QUESTION

Which combination will give strongest ionic bond ?

1. Na^+ and Cl^-

2. Mg^{2+} and Cl^- ✗ $MgCl_2$ Cov. ch. ↑

3. Na^+ and O^{2-}

4. Mg^{2+} and O^{2-} ✓ $Mg^{+2}O^{-2}$ High L.E Strong Ionic Bond.

QUESTION

Amongst the following trihalides, which one is least basic?

1. NF_3
2. NCl_3
3. NBr_3
4. NI_3

Lewis Basis ∝ l·p donation

+δ ↑ ⟶ EN ↑ ⟶ l-p donation tendency ↓se

QUESTION

Which of the following statement is correct ?

1. PH_3 is more basic than NH_3
2. PH_3 is equally basic as NH_3 ✗
3. PH_3 is less basic than NH_3
4. PH_3 is amphoteric while NH_3 is basic ✗

NH_3
PH_3
AsH_3
SbH_3

l.p directional nature ↓

L.B.L.

(A) $\ddot{N}H_3 + H^+ \longrightarrow NH_4^+$

(B) $\ddot{P}H_3 + H^+ \longrightarrow PH_4^+$

which reaction is fast ⇒

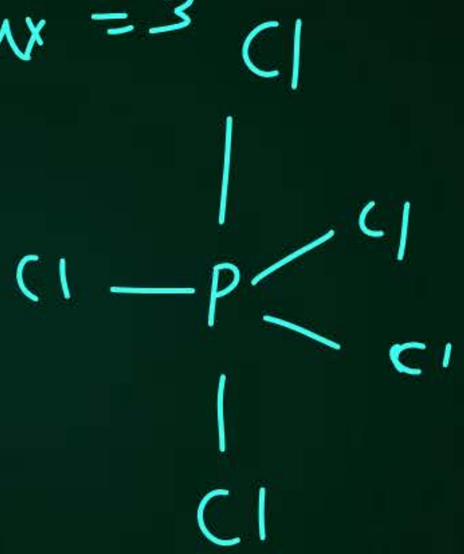
(A)

QUESTION

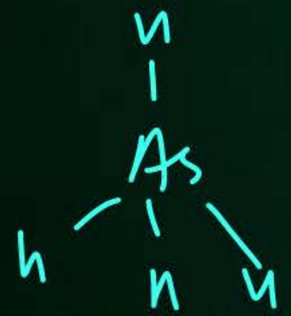
In which of the following species maximum atom lie in same plane ?

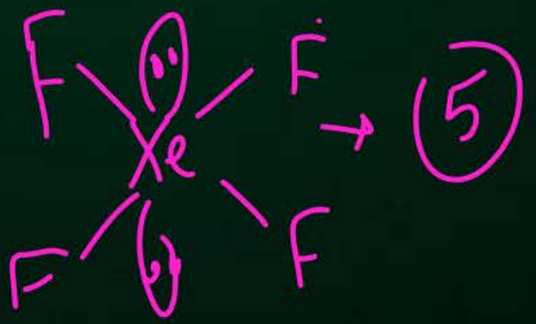
1. XeF_2O_2
2. PCl_5
3. AsH_4^+
4. XeF_4

Max = 3



Max = 4





QUESTION

In which of the following molecular shape dz^2-orbital must not be involved in bonding ?

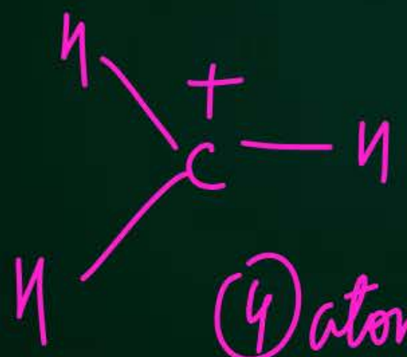
1. Pentagonal planar
   (AB_5L_2) sp^3d^3
2. Trigonal planar
   AB_3L_0 sp^2
3. Linear
   AB_2L_0 (sp) & AB_2L_3 (sp^3d)
4. Square planar
   AB_4L_2 sp^3d^2

QUESTION

According to VSEPR theory, in which spices do all the atoms lie in the same plane ?

1. CH_3^+ 2. CH_3^-

1. 1 only
2. 2 only
3. Both 1 and 2
4. Neither 1 nor 2



(4) atom

T. Planar.

QUESTION

Which of the following orbitals can not undergo hybridization ?

(i) 3d, 4s (ii) 3d, 4d (iii) 3d, 4s & 4p (iv) 3s, 3p & 4s

1. only ii
2. ii & iv
3. ii & iii
4. i, ii & iv

3d 4s 4p 4d

Inner d Complexes

d^2sp^3

dsp^3

dsp^2

3d 4s 4p 4d

outer d complexes

sp^3d^2

sp^3d

Hybridisation → Energy gas should be Minimum

2s 2p

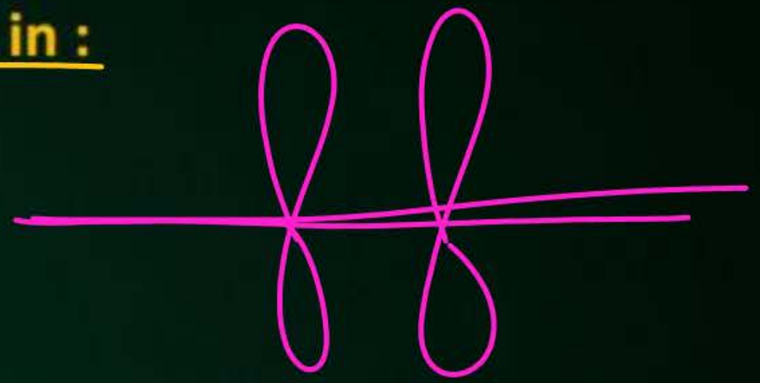
3s 3p

3s 3p 3d

4s 4p

QUESTION

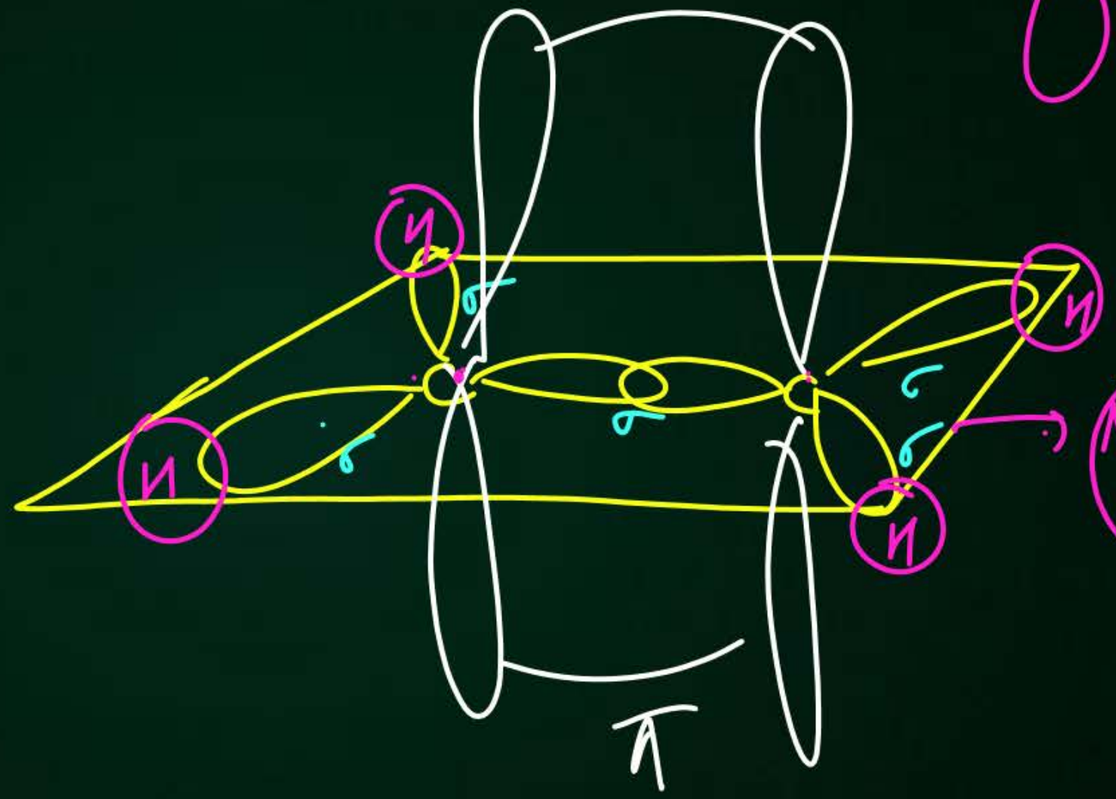
The nodal plane in the π-bond of ethene is located in :

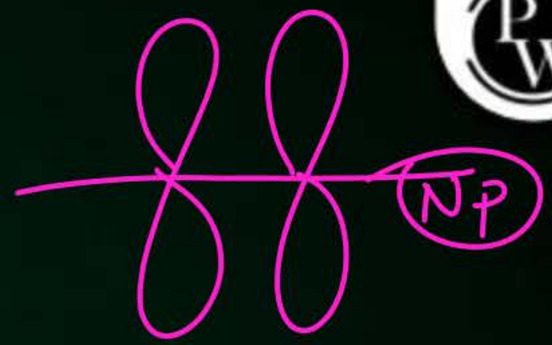


1. The molecular plane
2. A plane parallel to the molecular plane
3. A plane perpendicular to the molecular plane which bisects the carbon-carbon σ bond at right angle
4. A plane perpendicular to the molecular plane which contains the carbon-carbon bond

$CH_2 = CH_2$

sp^2 sp^2





σ & π

Perpendicular to each other.

QUESTION

$SiF_4 + HF \longrightarrow [SiF_6]^{2-}$ or $H_2[SiF_6]$

(Si in SiF_4: sp^3; Si in $[SiF_6]^{2-}$: sp^3d^2)

$SiF_4 + HF \rightarrow$ No Rxn

In which reaction, hybridization of underlined atom remains unchanged ?

1. Combustion of $\underline{CH_4} \rightarrow CO_2$

(C in CH_4: sp^3; C in CO_2: sp)

2. Solidification of $\underline{PCl_5}$ vapour

(P in PCl_5: sp^3d)

$PCl_5 \rightarrow$ solid $\left\langle \begin{array}{l} PCl_4^+ \ (sp^3) \\ PCl_6^- \ (sp^3d^2) \end{array} \right.$

3. SiF_6 vapour is passed through liq. HF

4. $\underline{Al(OH)_3}$ ppt, dissolve in NaOH

$Al(OH)_3 + OH^- \longrightarrow Al(OH)_4^-$

(Al in $Al(OH)_3$: sp^2; Al in $Al(OH)_4^-$: sp^3)

$NaOH + Al + H_2O \rightarrow Al(OH)_3 + OH^- \rightarrow Na[Al(OH)_4]$

QUESTION

Which of the following xenon compound has the same number of lone paris as in I_3^- ?

at C.A

I_3^- AB_2L_3

1. XeO_4 AB_4L_0
2. XeF_4 AB_4L_2
3. XeF_2 AB_2L_3
4. XeO_3 AB_3L_1

QUESTION

The lowest O – O bond length in the following molecule is :

1. O_2F_2
2. O_2
3. H_2O_2
4. O_3

B.O = 1

O_2 = 2

H_2O_2 = 1

O_3 1.5

QUESTION

Select the correct statement :

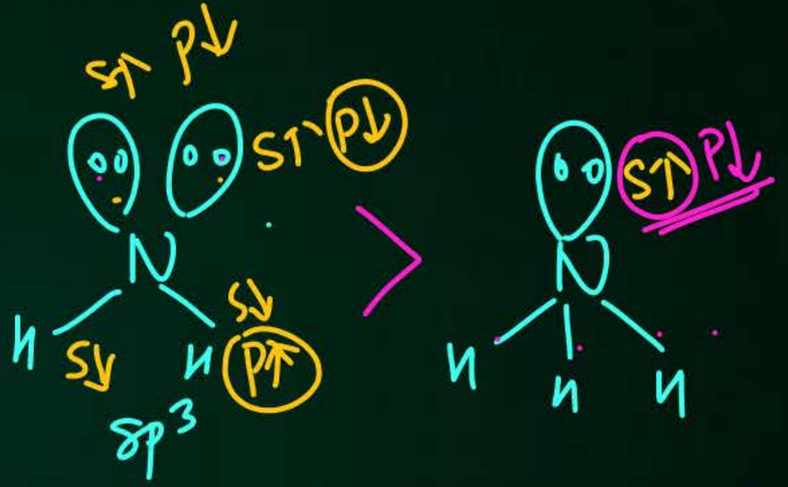
1. B–F bond length in $BF_3 > BF_4^-$ ✗ (sp^2 vs sp^3)

2. N–H bond length in $NH_3 > NH_2^-$ (sp^3 vs sp^3)

3. P–H bond length in $PH_3 > PH_4^+$ ✓

Negligible mixing of 3s

4. C–H bond length in $CH_3^+ > CH_4$ ✗ (sp^2 vs sp^3)



PH_3

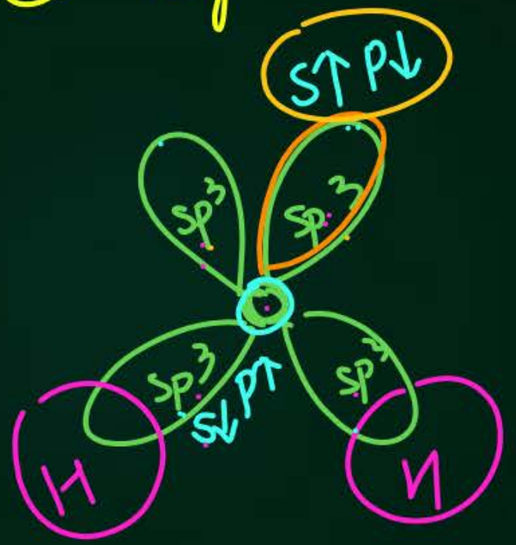
P—H bonds are formed by almost pure p orbitals.

Bent's Rule with MDJ

① l.p ko "s" pasand hai

② High EN ko "p" pasand hai.

$\theta < 109.5^\circ$



s %	p %	
25	75	sp^3
1/4	3/4	

1 : 3

s↑ θ↑
p↑ length↑

QUESTION

Which of the following attraction is strongest ?

1. Cl^- ..... H–Cl — I.D

2. $CHCl_3$ ..... $CHCl_3$ — D.D ✗

3. CCl_4 ..... H_2O — D.I.D ✗
   (NP) (P)

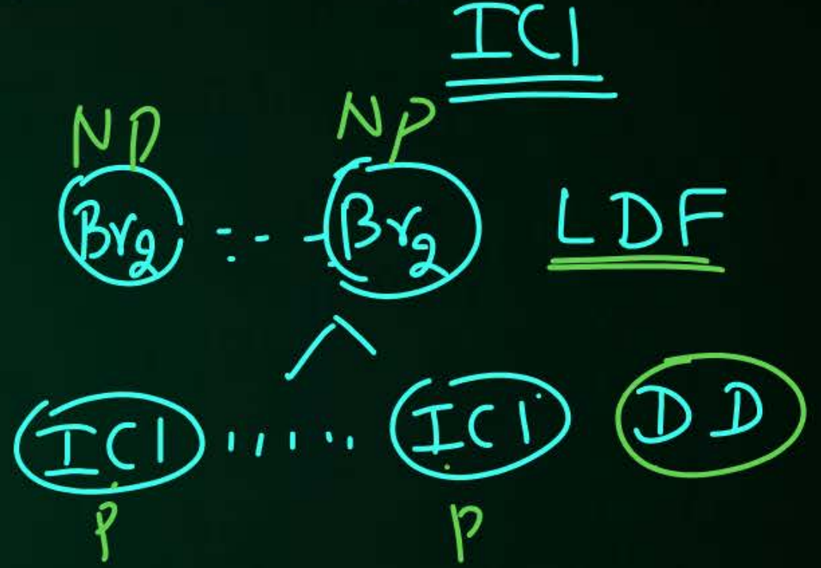
4. Cl^- ..... H_2O — I.D ✓

$H_2O > HCl$ Polarity (μ)

QUESTION

The molecular size of ICl and Br_2 is approximately same, but b.p. if Icl is about 40°C higher than that of Br_2. It is because :

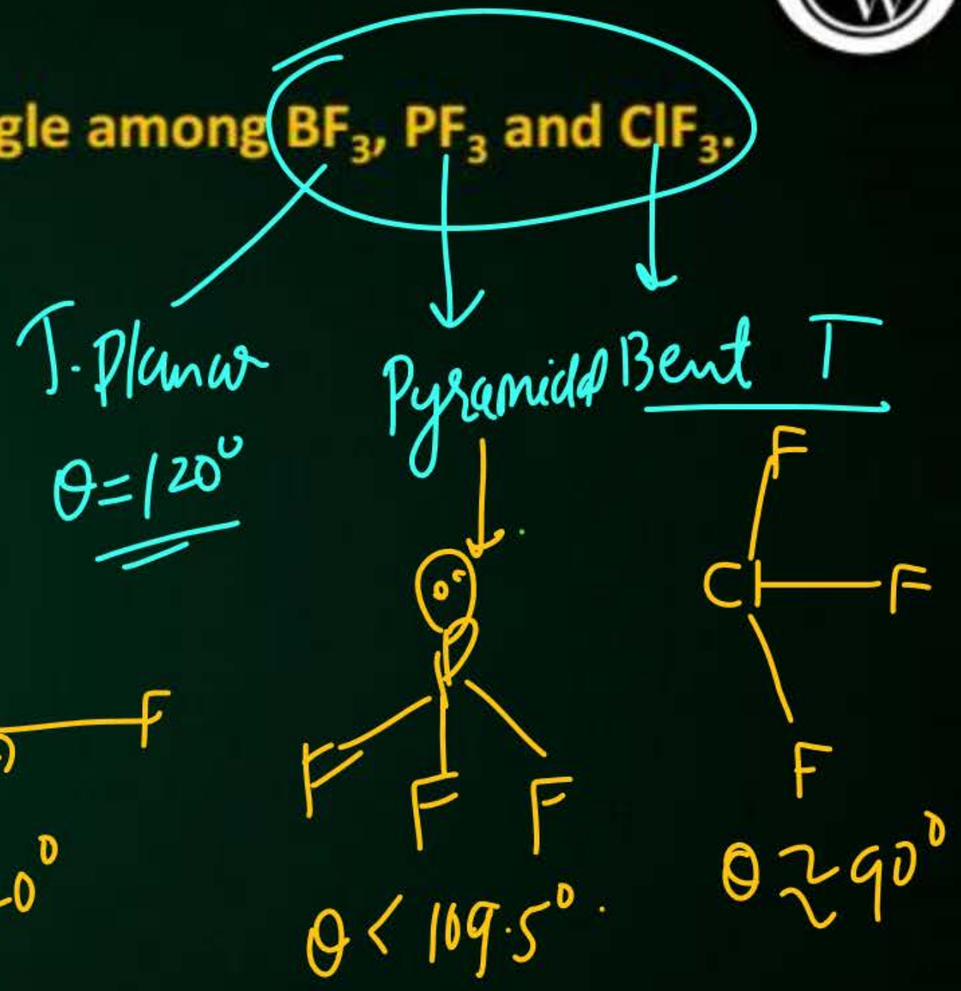
1. ICl bond is stronger than Br – Br bond
2. IE of iodine < IE of bromine
3. ICl is polar while Br_2 is nonpolar
4. I has larger size than Br



QUESTION

The correct increasing order of adjacent bond angle among BF_3, PF_3 and ClF_3.

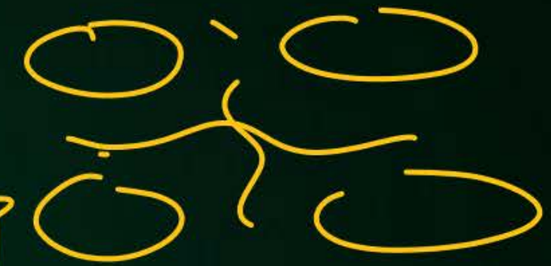
1. $BF_3 < PF_3 < ClF_3$
2. $PF_3 < BF_3 < ClF_3$
3. $ClF_3 < PF_3 < BF_3$
4. $BF_3 = PF_3 = ClF_3$



QUESTION

Low melting point is expected for a solid :

1. Ionic solid
2. Metallic solid
3. Molecular solid (Small Covalent Compounds)
4. Covalent solid (or Network solid diamond, graphite SiO_2 etc.) } giant covalent compounds.

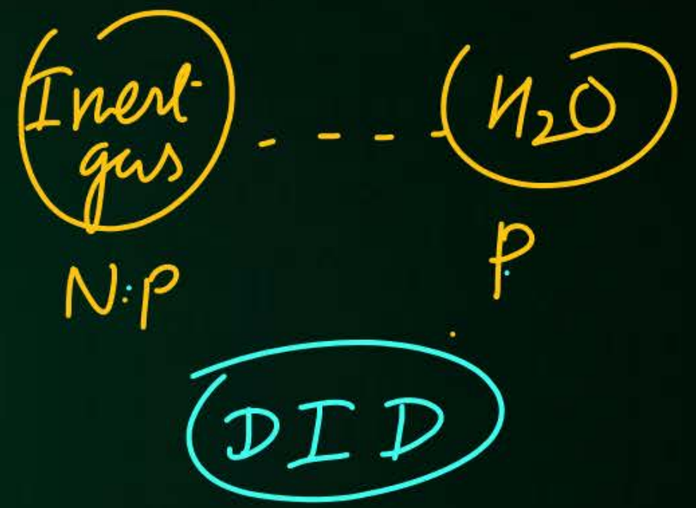


W.V.F forces b/w molecules

QUESTION

Solubility of inert gases increased as atomic number increases due to increase in

1. Dipole-dipole interaction
2. Dipole-induced dipole interaction
3. Induced dipole-instantaneous dipole interaction
4. Hydrogen bonding



QUESTION

Statement-1 : CCl_4 is a non-polar molecule.
Statement-2 : CCl_4 has polar bonds.

1. If statement-1 is true but the statement-2 is false.
2. If statement-1 is false but the statement-2 is true.
3. If both statements are true and the satemetn-2 is the correct explanation of statement-1.
4. If both statements are true and the satemetn-2 is not the correct explanation of statement-1.
5. Both statement are false.

QUESTION

A—13

Statement-1 : All diatomic molecules with polar bond have dipole moment.
Statement-2 : Dipole moment is a vector quantity.

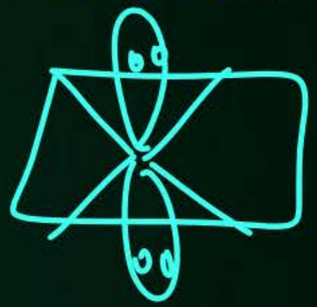
1. If statement-1 is true but the statement-2 is false.
2. If statement-1 is false but the statement-2 is true.
3. If both statements are true and the satemetn-2 is the correct explanation of statement-1.
4. If both statements are true and the satemetn-2 is not the correct explanation of statement-1.
5. Both statement are false.

QUESTION

AB_4L_2.

Statement-1 : The shape of XeF_4 is square-planar. ✓

Statement-2 : In an octahedral geometry, a single lone pair can occupy any position but a second lone pair will occupy position to the first lone pair.



1. If statement-1 is true but the statement-2 is false.
2. If statement-1 is false but the statement-2 is true.
3. If both statements are true and the satemetn-2 is the correct explanation of statement-1.
4. If both statements are true and the satemetn-2 is not the correct explanation of statement-1.
5. Both statement are false.

QUESTION

The correct statement with regards to H_2^+ and H_2^- is

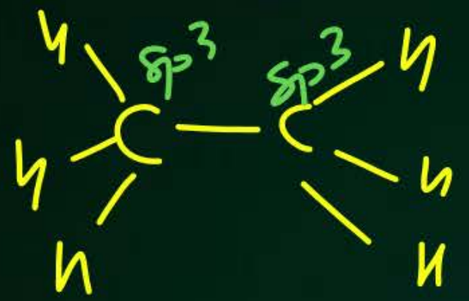
1. Both H_2^+ and H_2^- do not exist ✗
2. H_2^- is more stable than H_2^+ ✗
3. ✓ H_2^+ is more stable than H_2^-
4. Both H_2^+ and H_2^- are equally stable

If B.O is same

than stability $\propto \frac{1}{\text{ABMO } e^-}$

QUESTION

Which one of the following conversions involves change in both hybridization and shape ?



1. $CH_4 \rightarrow C_2H_6$ (sp^3 → sp^3)
2. $NH_3 \rightarrow NH_4^+$ (sp^3 → sp^3)
3. $BF_3 \rightarrow BF_4^-$ (sp^2 → sp^3, Tetra)
4. $H_2O \rightarrow H_3O^+$ (sp^3 → sp^3)

QUESTION

Which of the following substance has the highest melting point ?

1. $^{+2}Ba^{-2}O$
2. $^{+2}Mg^{-2}O$ ✓ — LET M.PT
3. $^{+1}K^{-1}Cl$ ✗
4. $^{+1}Na^{-1}Cl$ ✗

QUESTION

NH_3 has higher boiling point than expected because :

1. It forms NH_4OH with water
2. It has strong intermolecular hydrogen bonds
3. It has intermolecular hydrogen bonds
4. Its density decreases on freezing

H.W

QUESTION

MOT

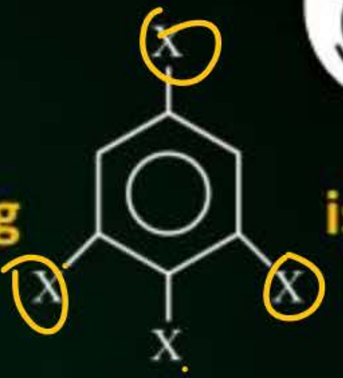
When O_2 is converted into O_2^+

$n=2$ $n=1$

1. Both paramagnetic character and bond order increase. ✗
2. Bond order decreases ✗
3. Paramagnetic character increases ✗
4. Paramagnetic character decreases and the bond order increses. ✓ ✓

QUESTION

Dipole moment of

is 1.5 D. The dipole moment of the following 

is :

1. 1.5 D
2. 2.35 D
3. 1 D
4. 3 D

QUESTION

Decreasing order of the hydrogen bonding in following forms of water is correctly represented by

A. Liquid water B. Ice C. Impure water

Choose the correct answer from the options given below: [JEE Main-2023]

1. A = B > C
2. A > B > C
3. C > B > A
4. B > A > C

QUESTION

The bond dissociation energy is higher for

[JEE Main-2023]

1. Br_2
2. F_2
3. Cl_2
4. I_2

$Cl_2 > Br_2 > F_2 > I_2$

F_2 → l.p - l.p repulsion

QUESTION

The correct order of hydration enthalpies is

(A) K^+ (B) Rb^+ (C) Mg^{2+} (D) Cs^+ (E) Ca^{2+}

Choose the correct answer from the options given below: [JEE Main-2023]

1. C > E > A > D > B

2. C > E > A > B > D

3. C > A > E > B > D

4. E > C > A > B > D

$Mg^{2+} > Ca^{2+} > K^+ > Rb^+ > Cs^+$

QUESTION

For OF_2 molecule consider the following:

A. Number of lone pairs on oxygen is 2.

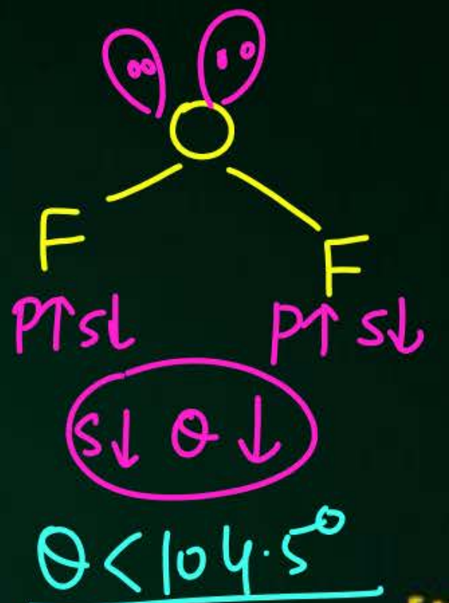
B. FOF angle is less than 104.5°.

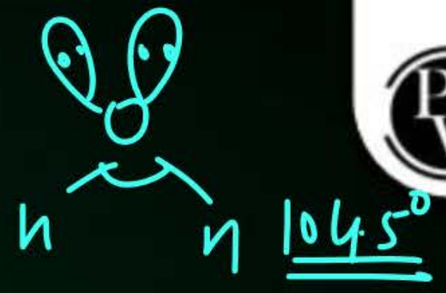
C. Oxidation state of O is –2.

D. Molecule is bent 'V' shaped.

E. Molecular geometry is linear.

Correct options are:





F High EN
"P" Pasand
Nai

[JEE Main-2023]

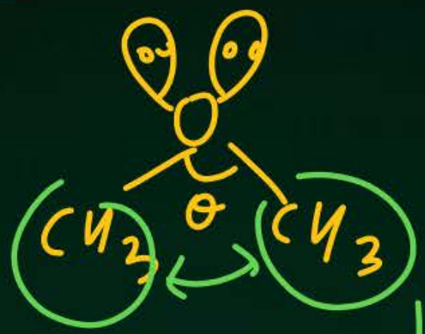
$OF_2 < H_2O$

0

1. A, B, D only
2. B, E, A only
3. A, C, D only
4. C, D, E only

Some Data based but Imp Ex.

$O(CH_3)_2$



$\theta < 109.5^\circ$

Large group more repulsion

$\theta \approx 119^\circ$

$OF_2 < H_2O$

$\theta < 104.5^\circ \quad \theta = 104.5$

QUESTION

Match List-I with List-II

List-I	List-II
A. XeF_4	I See saw
B. SF_4	II. Square planar
C. NH_4^+	III. Bent T-shaped
D. BrF_3	IV. Tetrahedral

H.W

Choose the correct answer from the options given below: [JEE Main-2023]

1. A-II, B-I, C-III, D-IV
2. A-IV, B-I, C-II, D-III
3. A-IV, B-III, C-II, D-I
4. A-II, B-I, C-IV, D-III

QUESTION

The correct order of bond enthalpy (kJ mol^{-1}) is :

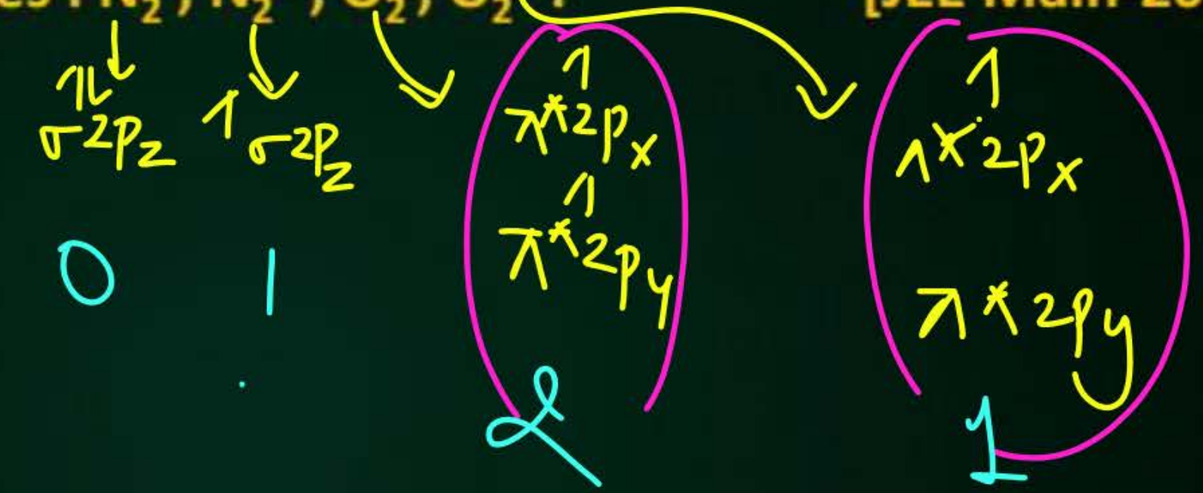
[JEE Main-2023]

1. C–C > Si–Si > Sn–Sn > Ge–Ge
2. Si–Si > C–C > Sn–Sn > Ge–Ge
3. C–C > Si–Si > Ge–Ge > Sn–Sn
4. Si–Si > C–C > Ge–Ge > Sn–Sn

H.W

QUESTION

What is the number of unpaired electron(s) in the highest occupied molecular orbital of the following species : N_2 ; N_2^+ ; O_2 ; O_2^+ ? [JEE Main-2023]

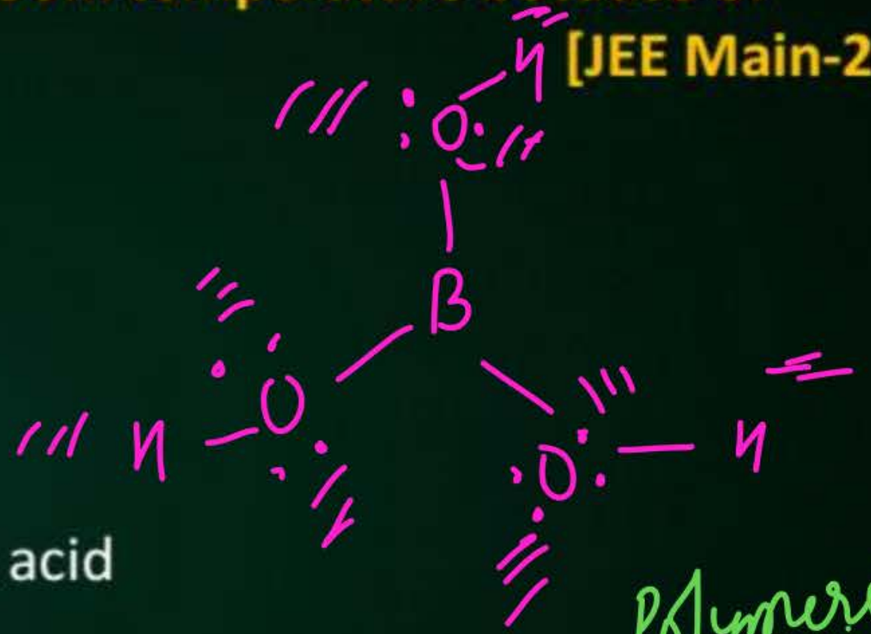


1. 0, 1 ,2, 1
2. 0, 1, 0, 1
3. 2, 1, 0, 1
4. 2, 1, 2, 1

QUESTION

Boric acid is solid, whereas BF_3 is gas at room temperature because of [JEE Main-2023]

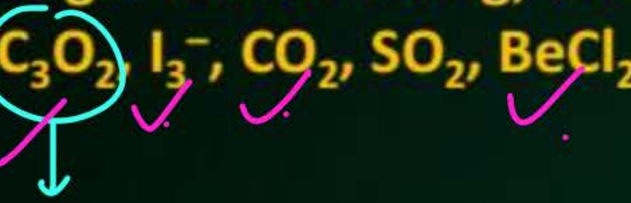
1. Strong covalent bond in BF_3
2. Strong ionic bond in Boric acid
3. Strong van der Waal's interaction in Boric acid
4. Strong hydrogen bond in Boric acid ✓



Polymeric in solid due to H-Bonding

QUESTION

Amongst the following, the number of species having the linear shape is XeF_2, I_3^+, C_3O_2, I_3^-, CO_2, SO_2, $BeCl_2$ and $BCl_2^{\ominus}$. [JEE Main-2023]



QUESTION

In which of the following pairs of molecules/ions, the central atoms have sp^2 hybridization? [AIPMT PRE-2010]

H.W

1. BF_3 and NH_2^-
2. NO_2^- and NH_3
3. BF_3 and NO_2^-
4. NH_2^- and H_2O

QUESTION

The maximum number of 90º angles between bond pair-bond pair of electrons is observed in : [AIEEE- 2004]

1. sp^3 hybridisation

H.W

2. sp^3d^2 hybridisation

3. sp^2 hybridisation

4. sp^3d hybridisation

QUESTION

In which of the following molecules/ions, all the bonds are not equal ?

[AIEEE- 2006]

1. SF_4 AB_4L_1 axial > eq.
2. SiF_4 AB_4L_0
3. XeF_4 AB_4L_2 a = e
4. BF_4^- AB_4L_0

QUESTION

Which of the following molecules/ions does not contain unpaired electrons?

[AIEEE- 2006]

H.W

1. O_2^{2-}
2. B_2
3. N_2^+
4. O_2

QUESTION

What is the dominant intermolecular force or bond that must be overcome in converting liquid CH_3OH to a gas ? **[AIPMT - 2009]**

1. London dispersion force
2. Hydrogen bonding
3. Dipole-dipole interaction
4. Covalent bonds

$CH_3OH \cdots CH_3OH$

(H-Bonding)

QUESTION

Which of the following is least likely to behave as Lewis base?

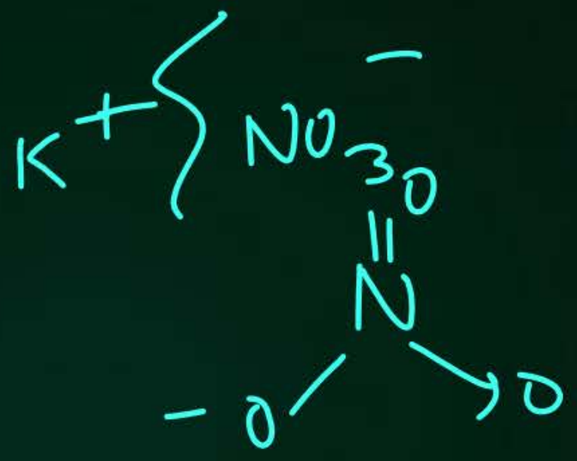
[AIPMT PRE-2011]

1. H_2O
2. NH_3
3. BF_3 (L.A)
4. OH^-

QUESTION

Which of the following compound contains(s) no covalent bonds(s) ?

KCl, PH_3, O_2, B_2H_6, H_2SO_4, KNO_3 [JEE Main - 2018]



1. KCl, B_2H_6, PH_3
2. KCl, H_2SO_4
3. KCl, KNO_3
4. KCl

QUESTION

According to molecular orbital theory, which of the following will not be a viable molecule : [JEE Main - 2018]

1. He_2^{2+}
2. He_2^{+}
3. H_2^{-}
4. H_2^{2-}

Hint

B.O = zero

H.W

QUESTION

The intermolecular interaction that is dependent on the inverse cube of distance between the molecules is : **[JEE Main - 2015]**

1. Ion-ion interaction
2. Ion-dipole interaction
3. London force
4. Hydrogen bond

$F \propto \frac{1}{r^3}$

H.W

QUESTION

The molecule having smallest bond angle is :

[AIEEE - 2012]

1. NCl_3
2. $AsCl_3$
3. $SbCl_3$
4. PCl_3

C.A ↑ O.L

H.W

QUESTION

Which one of the following species does not exist under normal conditions ?

[AIPMT PRE-2010]

1. Li_2
2. Be_2^+
3. Be_2
4. B_2

Hint

B.O = 0

H.W

QUESTION

In which of the following molecules the central atom does not have sp^3 hybridization : [AIPMT MAINS-2010]

1. SF_4
2. BF_4^-
3. NH_4^+
4. CH_4

H.W

QUESTION

Which one of the following elements is unable to form MF_6^{3-} ion ?

[NEET- 2018]

1. Ga
2. Al
3. B
4. In

H.W

QUESTION

An ether is more volatile than an alcohol having the same molecular formula. This is due to : **[AIEEE - 2003]**

1. dipolar character of ethers

2. alcohols having resonance structures

3. inter-molecular hydrogen bonding in ethers

4. inter-molecular hydrogen bonding in alcohols

QUESTION

Which one of the following compounds has the smallest bond angle in its molecule ? [AIEEE - 2003]

1. SO_2.
2. OH_2 H_2O
3. SH_2 H_2S ✓
4. NH_3

QUESTION

Which one of the following pairs of molecules will have permanent dipole moments for both members ? [AIEEE - 2003]

1. SiF_4 and NO_2

2. NO_2 and CO_2

3. NO_2 and O_3

4. SiF_4 and CO_2

QUESTION

Which one of the following statement about water is false ?

[JEE Main - 2016]

1. Water can act both as acid and as a base

$H_2O + NH_3$ (Acid.)

$H_2O + H_2S$ (Base)

2. There is extensive intramolecular hydrogen bonding in the condensed phase

3. Ice formed by heavy water sinks in normal water

4. None of these

QUESTION

The correct statement for the molecule, CsI_3 is

[JEE Main - 2014]

H.W

1. It is covalent molecule
2. It contains Cs^+ and I_3^-
3. It contains Cs^{3+} and I^- ions
4. It contains Cs^+, I^- and lattice I_2 molecule

QUESTION

Which one has the highest boiling point ?

[JEE Main - 2015]

1. He
2. Ne
3. Kr
4. Xe

H.W

QUESTION

Which of the following order is not correct ?

1, 3

1. $NaCl > MgCl_2 > AlCl_3$ (Covalent character)
2. $PO_4^{3-} > CO_3^{2-} > SO_4^{2-}$ (Formal change on terminal oxygen)
3. $N - N > P - P$ (Single bond strength)
4. $2p - 2p > 2s - 2p > 2s - 2s$ (Bond strength)

QUESTION

Find out the correct order of Dipole moment :

1. $SO_2 = CO_2$
2. $BF_3 = BeCl_2 = XeF_2$
3. $H_2O < H_2S$
4. $NH_3 < NF_3$

H.W

QUESTION

In which one of the following species the central atom has the type of hybridisation which is not the same as that present in the other three ?

[AIPMT PRE-2010]

1. PCl_5
2. SF_4
3. I_3^-
4. $SbCl_5^{2-}$

QUESTION

Which of the following is a polar molecule ?

[NEET(UG)-2013]

1. XeF_4
2. BF_3
3. SF_4
4. SiF_4

QUESTION

Which of the following hydrogen bonds is the strongest ?

[JEE Main- 2007]

1. O–H.....N
2. F–H.....F
3. O–H.....O
4. O–H.....F

QUESTION

The correct order of C–O bond length among CO, CO_3^{2-}, CO_2 is :

[AIPMT - 2007]

1. $CO < CO_2 < CO_3^{2-}$
2. $CO_2 < CO_3^{2-} < CO$
3. $CO < CO_3^{2-} < CO_2$
4. $CO_3^{2-} < CO_2 < CO$

H.W

QUESTION

H.W

The electronegativity difference between N and F is greater than that between N and H yet the dipole moment of NH_3 (1.5 D) is larger than that of NF_3 (0.2 D). This is because :

1. In NH_3 the atomic dipole and bond dipole are in the opposite directions whereas in NF_3 these are in the same direction

2. In NH_3 as well as in NF_3 the atomic dipole and bond dipole are in the same direction

3. In NH_3 the atomic dipole and bond dipole are in the same direction whereas in NF_3 these are in opposite directions

4. in NH_3 as well as NF_3 the atomic dipole and bond dipole are in opposite directions

QUESTION

In which of the following processes, the value of magnetic moment does not changes ?

1. $N_2 \longrightarrow N_2^{-2}$

   $n=0$ $\quad$ $n=2$

2. $B_2 \longrightarrow B_2^{-2}$

   $n=0$ $\quad$ $n=0$

3. $O_2^{+} \longrightarrow O_2^{-}$

   $n=1$ $\quad$ $n=1$

4. $O_2^{-} \longrightarrow O_2^{-2}$

   $n=1$ $\quad$ $n=0$

QUESTION

No change in π bonds order in reaction :

1. $N_2 \longrightarrow N_2^-$
2. $B_2 \longrightarrow B_2^-$
3. $O_2^{-2} \longrightarrow O_2^-$
4. $C_2 \longrightarrow C_2^{-2}$

$2\pi \quad 2\pi + 1\sigma$

C_2^{2-}

1ν
$\pi 2p_x$
1ν
$\pi 2p_y$
2π

1ν
$\sigma 2p_z$
1σ

$+$

QUESTION

Formal change on nitrogen and oxygen in NO_3^- ion are respectively :

1. $0, \frac{-1}{3}$
2. $+1, \frac{-2}{3}$
3. $+1, \frac{-1}{3}$
4. $0, \frac{-2}{3}$

H.W

QUESTION

According to molecule orbital theory which of the following is correct ?

1. LUMO level for C_2 molecule is a $\sigma 2p$ orbital

2. In C_2 molecule both the bonds are π bonds

3. In C_2^{2-} ion there is one σ and two π bonds

4. All the above are correct

QUESTION

For which of the following molecule significant $\mu \neq 0$?

H.W

1. Only (c)
2. (c) And (d)
3. Only (a)
4. (a) and (b)

(a)

(b)

(c)

(d)

QUESTION

The molecule which possesses both sp^3 and sp^3d^2 hybridisation is :

H.W

1. solid PCl_5
2. gaseous PCl_5
3. solid PBr_5
4. gaseous PBr_5

QUESTION

In which of the following s-p mixing is not operative :

1221

1. N_2
2. C_2
3. O_2
4. B_2

QUESTION

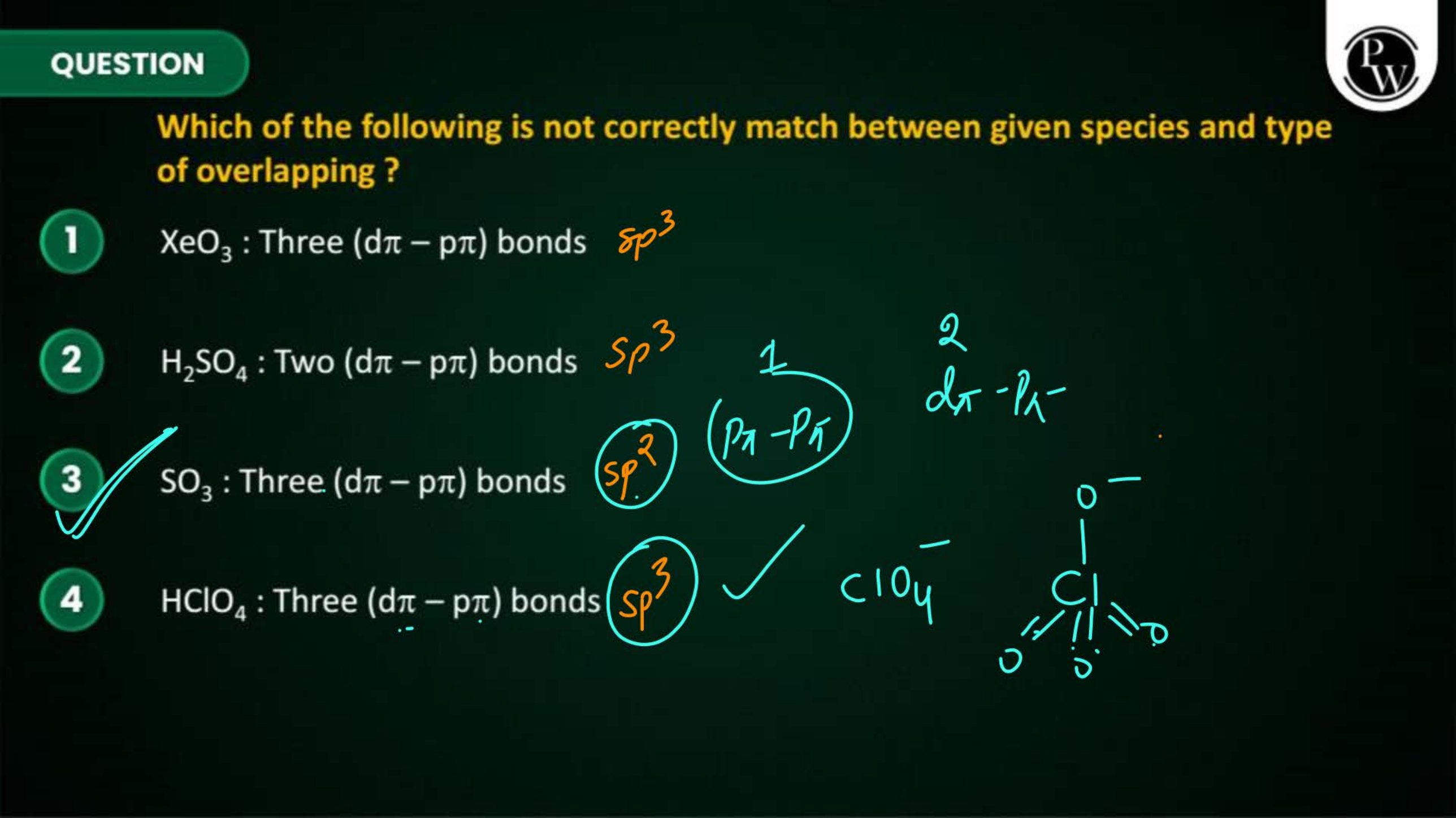
Which of the following is not correctly match between given species and type of overlapping ?

1. XeO_3 : Three ($d\pi - p\pi$) bonds

2. H_2SO_4 : Two ($d\pi - p\pi$) bonds

3. SO_3 : Three ($d\pi - p\pi$) bonds

4. $HClO_4$: Three ($d\pi - p\pi$) bonds



QUESTION

The pairs of species of oxygen and their magnetic behaviours are noted below. Which of the following presents the correct description ?

1. O_2, O_2^{2-} - Both paramagnetic

2. O_2^-, O_2^{2-} - Both diamagnetic

3. O_2^+, O_2^{2-} - Both paramagnetic

4. O_2^+, O_2 - Both paramagnetic

QUESTION

Which of the following statement is incorrect ?

1. Dipole moment of CH_3Cl is greater than CH_3F
2. ICl_2^- has a linear shape
3. XeF_2 has two lone pair of electrons
4. SF_2 is non linear molecule

H.W

QUESTION

In which of the following pairs, the hybridisation of central atoms is same, but molecular geometry is not the same ?

1. SO_3, CO_3^{2-}

2. SO_3^{2-}, NH_3

3. PCl_5, $POCl_3$

4. XeF_2, ICl_3

H.W

QUESTION

Intermolecular H-bonding is present :

1. H_2O
2. p-nitrophenol
3. H_3BO_3(solid)
4. All of these

QUESTION

What is the hybridisation state of central atom and shape in conjugate base of ammonium ion :

1. sp^3, trigonal planer
2. sp^2, trigonal planer
3. sp^3, pyramidal
4. sp^3d, T-shape

$NH_4^+ \xrightarrow{-H^+}$ NH_3

sp^3

QUESTION

Which intermolecular force is most responsible for liquefaction of inert gas ?

1. Ionic
2. Instantaneous dipole – induced dipole
3. Dipole – dipole
4. Ion – dipole

Ne - Ne
LDF

QUESTION

Correct match is/are :

	Compound		Hybridisation/shape
1	$SiCl_4$	:	See-Saw
2	SF_4	:	sp^3
3	H_3O^+	:	Pyramidal
4	All of these		

H.W

QUESTION

Which of the following pair cannot exhibit covalency more than four ?

1. P, S
2. B, N
3. Cl, Si
4. None of these

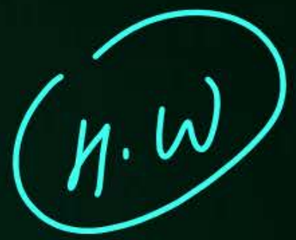
H.W

QUESTION

Out of given species how many are contains σ coordinate bond

PCl_6^- , PCl_5, PH_4^+, NH_4Cl, NH_4^+, BF_3, NO_3^-

1. 2
2. 5
3. 4
4. 3



QUESTION

Correct statement about NO_2

1. $O - \hat{N} - O$ bond angle is $< 120°$
2. Hybridisation of N is sp
3. It is a brown coloured gas and diamagnetic
4. None of these

QUESTION

Which of the following species is not stable ?

1. $[SiF_6]^{2-}$
2. $[GeCl_6]^{2-}$
3. $[Sn(OH)_6]^{2-}$
4. $[SiCl_6]^{2-}$

1 Votes

QUESTION

Select correct statement about CH_4

1. All the hybrid orbitals of carbon are equivalent
2. All the hybrid orbitals of carbon have 25% 2s property
3. All the hybrid orbitals of carbon are projected at the four vertex of a regular tetrahedron
4. All are correct statements

QUESTION

According to VBT, which of the following overlapping results π-type covalent bond in O_2 molecule formation, when Z-axis is internuclear axis ?

(I) 2s-2s

(II) $2p_x - 2p_x$

(III) 1s-1s

(IV) $2p_y - 2p_y$

(V) $2p_z - 2p_z$

1. I, III
2. II, V
3. II, IV
4. IV, V

QUESTION

Correct order of lattice energy is

1. $K_2O < Rb_2O$
2. $NaF < KF$
3. $NaF < MgO$
4. $Al_2O_3 < MgO$

H.W

QUESTION

Find the correct order of covalent character in following :

1. $NaCl > MgCl_2$
2. $AgCl < AgF$
3. $NaCl > ZnCl_2$
4. $CaCl_2 < CdCl_2$

QUESTION

Lone pair having maximum directional nature present in :

1. BiH_3
2. SbH_3
3. NH_3
4. PH_3

NOTES

QUESTION

The pair of elements which on combination are most likely to form an ionic compound is :

1. Na and Ca
2. K and O_2
3. O_2 and Cl_2
4. Al and I_2

AlI_3 Fajan's Conv.

QUESTION

PCl_5 exists but NCl_5 does not because :

1. Nitrogen has no vacant d-orbitals

H.W

2. NCl_5 is unstable

3. Nitrogen atom is much smaller than P

4. Nitrogen is highly inert

QUESTION

Dative bond is present in :

1. O_3
2. NH_3
3. $BaCl_2$
4. BF_3

H.W

QUESTION

Select the correct relation.

1. $\mu\ NH_3 = \mu\ NF_3$
2. $\mu\ NH_3 > \mu\ NF_3$
3. $\mu\ NH_3 < \mu\ NF_3$
4. $\mu\ NH_3 >< \mu\ NF_3$

QUESTION

The correct order of decreasing polarizability of ion is :

1. $Cl^- > Br^- > I^- > F^-$
2. $F^- > I^- > Br^- > Cl^-$
3. $I^- > Br^- > Cl^- > F^-$
4. $F^- > Cl^- > Br^- > I^-$

H.W

QUESTION

Which p-orbitals overlapping would give the strongest bond ?

1

2

3

4

QUESTION

Which one of the following is paramagnetic and has bond order 1/2 ?

1. H_2
2. H_2^+
3. N_2
4. F_2

H.W

QUESTION

The shape of covalent molecule MX_3 is :

AB_3 → AB_3L_0 Planar
AB_3L_2 Bent T
AB_3L_1 Pyramidal

1. Triangular
2. T-shape
3. pyramidal
4. Either of these depending on number of lone pairs of electron on M

QUESTION

Which molecule is T-shaped ?

1. BeF_2
2. BCl_3
3. NH_3
4. ClF_3

QUESTION

Which shows a change in the type of hybridisation when

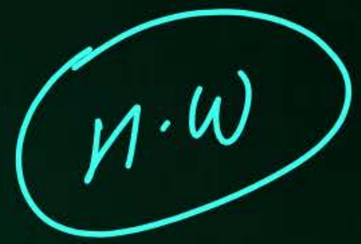
1. NH_3 combines with H^+
2. BF_3 combines with F^-
3. In both cases
4. In none of these cases

H.W

QUESTION

The species which does not show paramagnetic is :

1. O_2
2. O_2^+
3. O_2^{2-}
4. H_2^+



QUESTION

The correct increasing bond angles order is :

1. $BF_3 < NF_3 < PF_3 > ClF_3$

2. $ClF_3 > PF_3 < NF_3 < BF_3$

3. $BF_3 \approx NF_3 < PF_3 < ClF_3$

4. $BF_3 < NF_3 < PF_3 < ClF_3$

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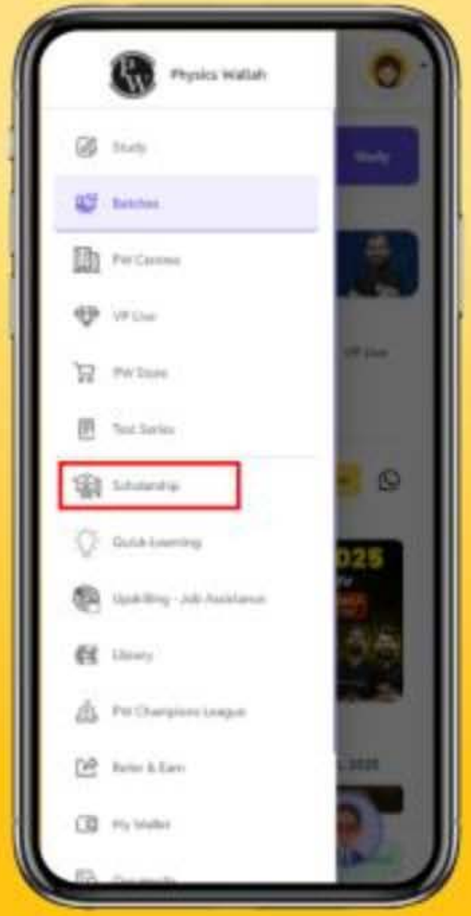

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NEET REAL TEST 01 SYLLABUS

11th NEET REAL TEST SERIES SYLLABUS

Cohort	Class	Name of the Test	Exam Date	Mode	Physics	Chemistry	Botany	Zoology
NEET	11	Test 1	13-Oct-2024	Online	Basic Maths & Calculus (Mathematical Tools) Vectors Units and Measurements Motion in a straight line	Structure of Atom Some Basic Concepts of Chemistry Classification of Elements and Periodicity in Properties	Cell - The Unit of Life Cell Cycle and Cell Division	Structural Organization in Animals Breathing and Exchange of Gases

12th NEET REAL TEST SERIES SYLLABUS

Cohort	Class	Name of the Test	Exam Date	Mode	Physics	Chemistry	Botany	Zoology
NEET	12	Test 1	13-Oct-2024	Online	Electric Charges and Fields Electrostatic Potential and Capacitance	Solution Electrochemistry	Sexual Reproduction in Flowering Plant	Human Reproduction

DROPPER NEET REAL TEST SERIES SYLLABUS

Cohort	Class	Name of the Test	Exam Date	Mode	Physics	Chemistry	Botany	Zoology
NEET	Dropper	Test 1	13-Oct-2024	Online	Basic Maths & Calculus (Mathematical Tools) Vectors Units and Measurements Motion in a straight line Motion in a plane Circular motion Laws of motion	Some Basic Concept of Chemistry Redox Reaction Solutions Thermodynamics Equilibrium Electrochemistry	Cell - The Unit of Life Cell Cycle and Cell Division The Living World Biological Classification Plant Kingdom Morphology of Flowering Plants	Structural Organization in Animals Breathing and Exchange of Gases Body Fluids and Circulation Excretory Products & their Elimination

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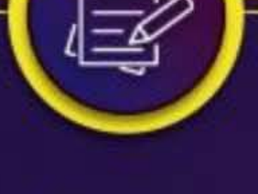

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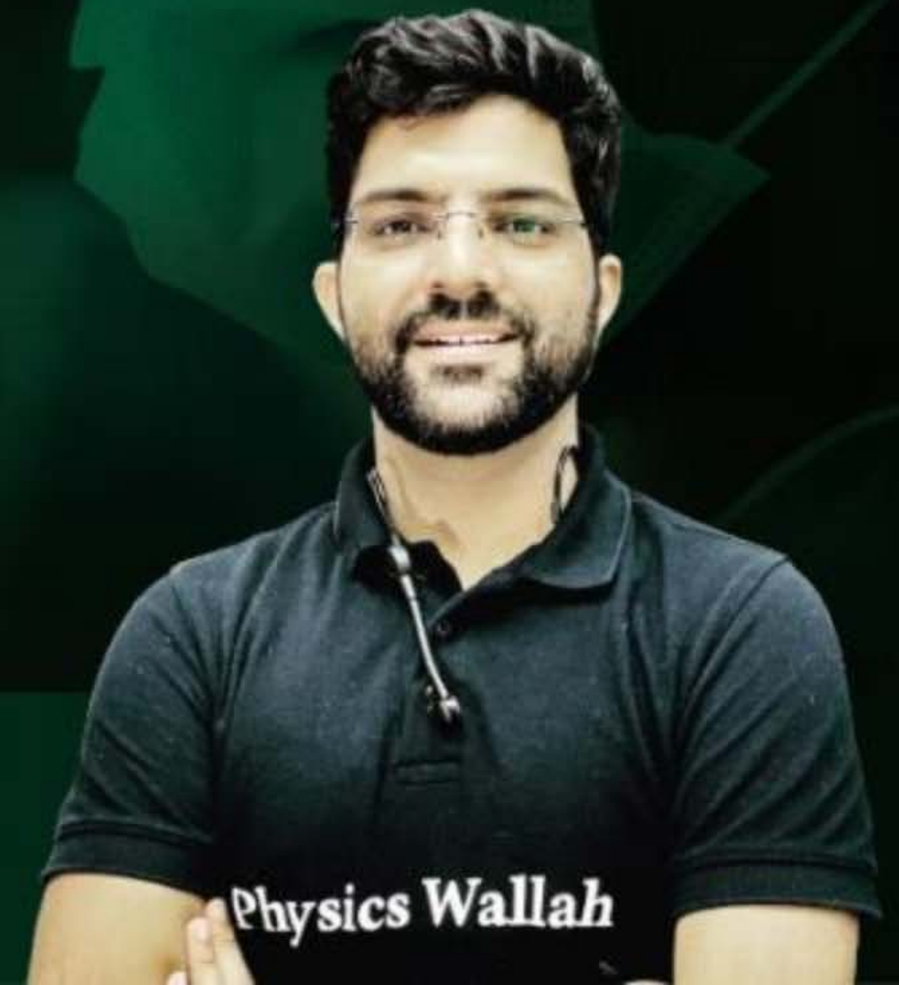
FOR NEET 2025

Lecture - 01 | Inorganic Chemistry

Coordination Compounds



By - Mohit Dadheech (MD Sir)

Topics *to be covered*

1. Introduction

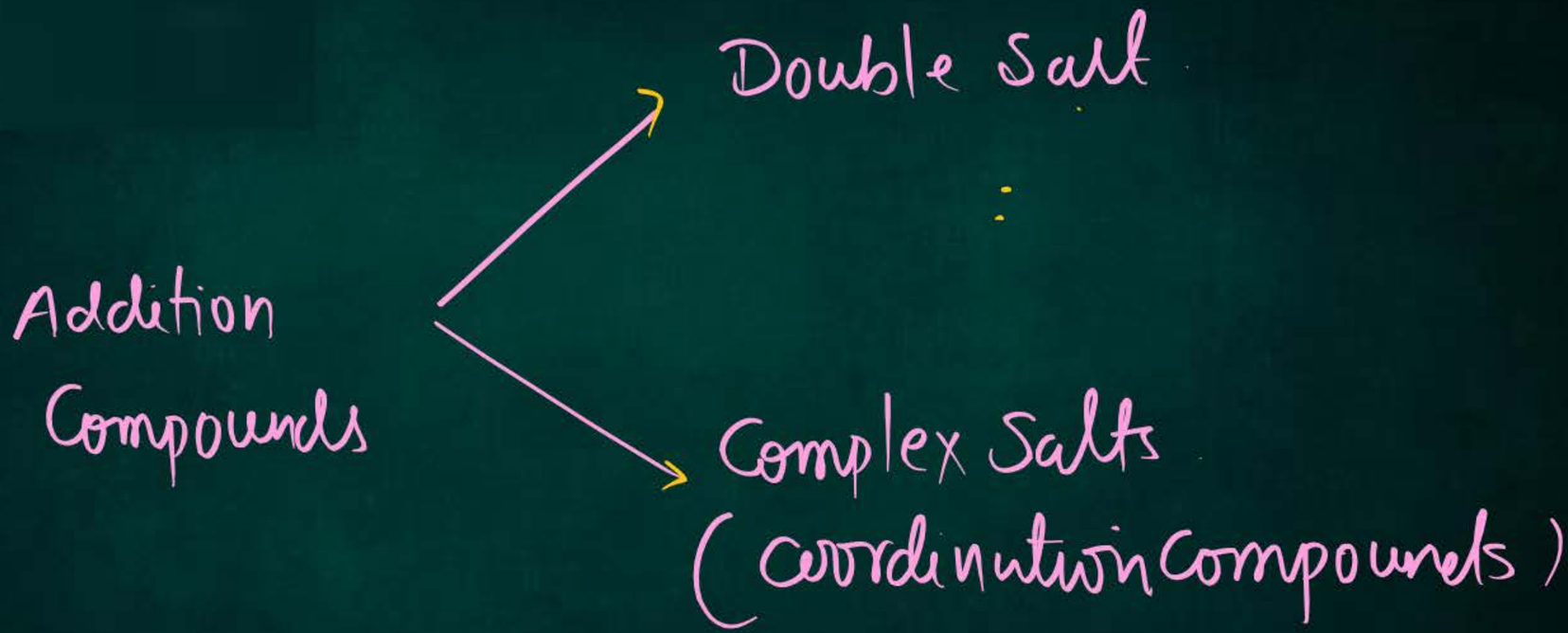
Introduction :

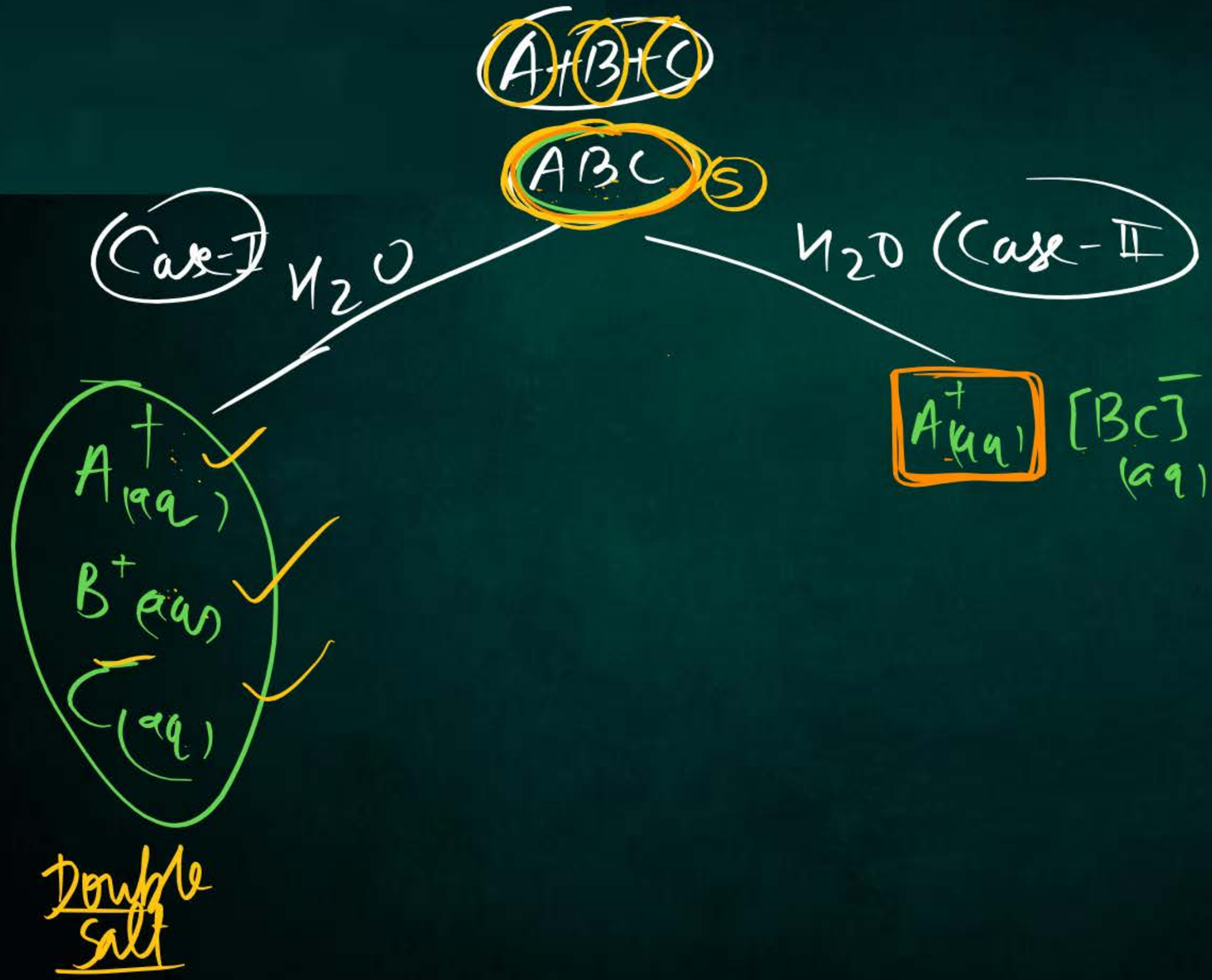
Addition Compounds :-

$$\text{Salt(A)} + \text{Salt(B)} + H_2O \xrightarrow{\Delta} \text{Crystals of Addition Compound}$$

Compounds made up of two or more stable.

Compounds by mixing them into fixed Stiochiometric ratio. (By Crystallisation Process)


Addition Compounds
Double Salt
Complex Salts
(Coordination Compounds)


A + B + C
ABC (s)
Case-I
H_2O
H_2O
Case-II
$A^+_{(aq)}$
$[BC]^-_{(aq)}$
$A^+_{(aq)}$
$B^+_{(aq)}$
$C^-_{(aq)}$
Double salt

Double Salt

→ Addition Compounds have their definite identity in solid but when dissolve in water they Completely dissociate(ionize)

→ Double Salts loose their identity in aq medium
(But individual ions retain their identity)

→ aq. Sol^{n} of double salt gives identification test for all its components(ions)

Complex Salt

→ These addition compounds Exist in solid as well as into aq. medium (do not ionize Completely)

→ Complex salts retain their identity in aq. medium

→ do not give test of all ions
(individual ions loose their identity)

Examples of Double Salt :-

(Imp)

(1) Alums (gen. Formula)

$X_2SO_4 \cdot M_2(SO_4)_3 \cdot 24H_2O$

X → Monovalent cation (X^+)

M → Trivalent cation (M^{3+})

(A) Potash Alum

K^+
Al^{3+}

$K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 24H_2O$

(B) Chrome alum

K^+, Cr^{3+}

$K_2SO_4 \cdot Cr_2(SO_4)_3 \cdot 24H_2O$

(C) Ferric Alum

NH_4^+
Fe^{3+}

$(NH_4)_2SO_4 \cdot Fe_2(SO_4)_3 \cdot 24H_2O$

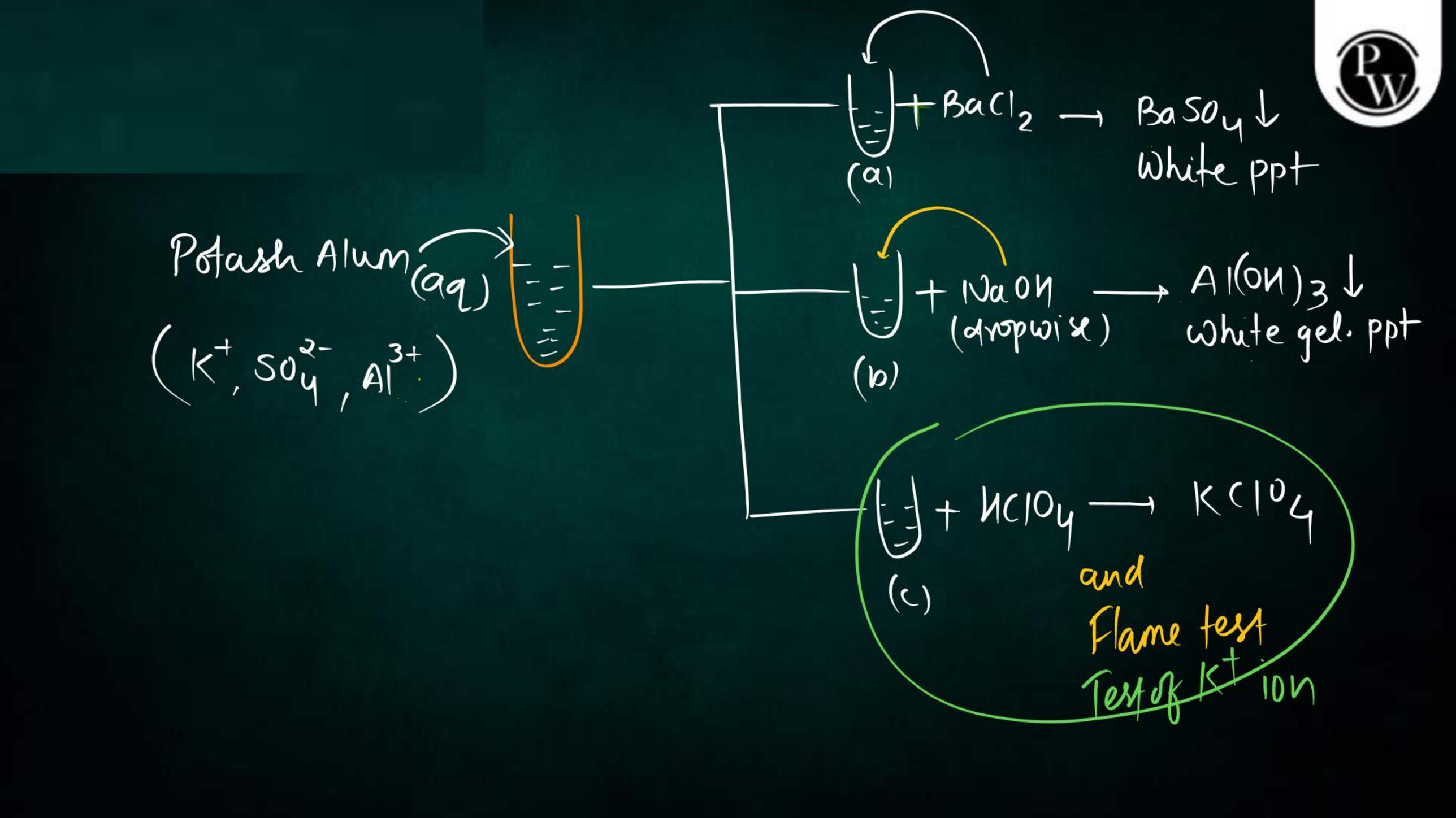
② F.A.S Ferrous Ammonium Sulphate
(Fe^{2+})

(Mohr's Salt)

$FeSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$

③ Carnalite

$KCl \cdot MgCl_2 \cdot 6H_2O$


Potash Alum (aq)
$(K^+, SO_4^{2-}, Al^{3+})$
(a)
$+ BaCl_2 \rightarrow BaSO_4 \downarrow$
White ppt
(b)
+ NaOH (dropwise) $\rightarrow Al(OH)_3 \downarrow$
White gel. ppt
(c)
$+ HClO_4 \rightarrow KClO_4$
and
Flame test
Test of K^+ ion

Examples of Complex Salts

Complete chapter.

For Ex (i) $K_4[Fe(CN)_6]$

$\downarrow H_2O$

$4K^+_{(aq)} \quad [Fe(CN)_6]^{4-}_{aq.}$

$\downarrow$

give test of K^+ ion.

But Fe^{2+} & CN^- will not give their positive test

Ex-ii

$CuSO_4$ + Excess NH_3 ⟶ $[Cu(NH_3)_4]SO_4$ (Switzer salt)

Blue colour

Dark Blue Colour.

Cu^{2+} test ✓

SO_4^{2-} test ✓

$[Cu(NH_3)_4]^{2+}_{(aq)}$

$SO_4^{2-}_{(aq)}$

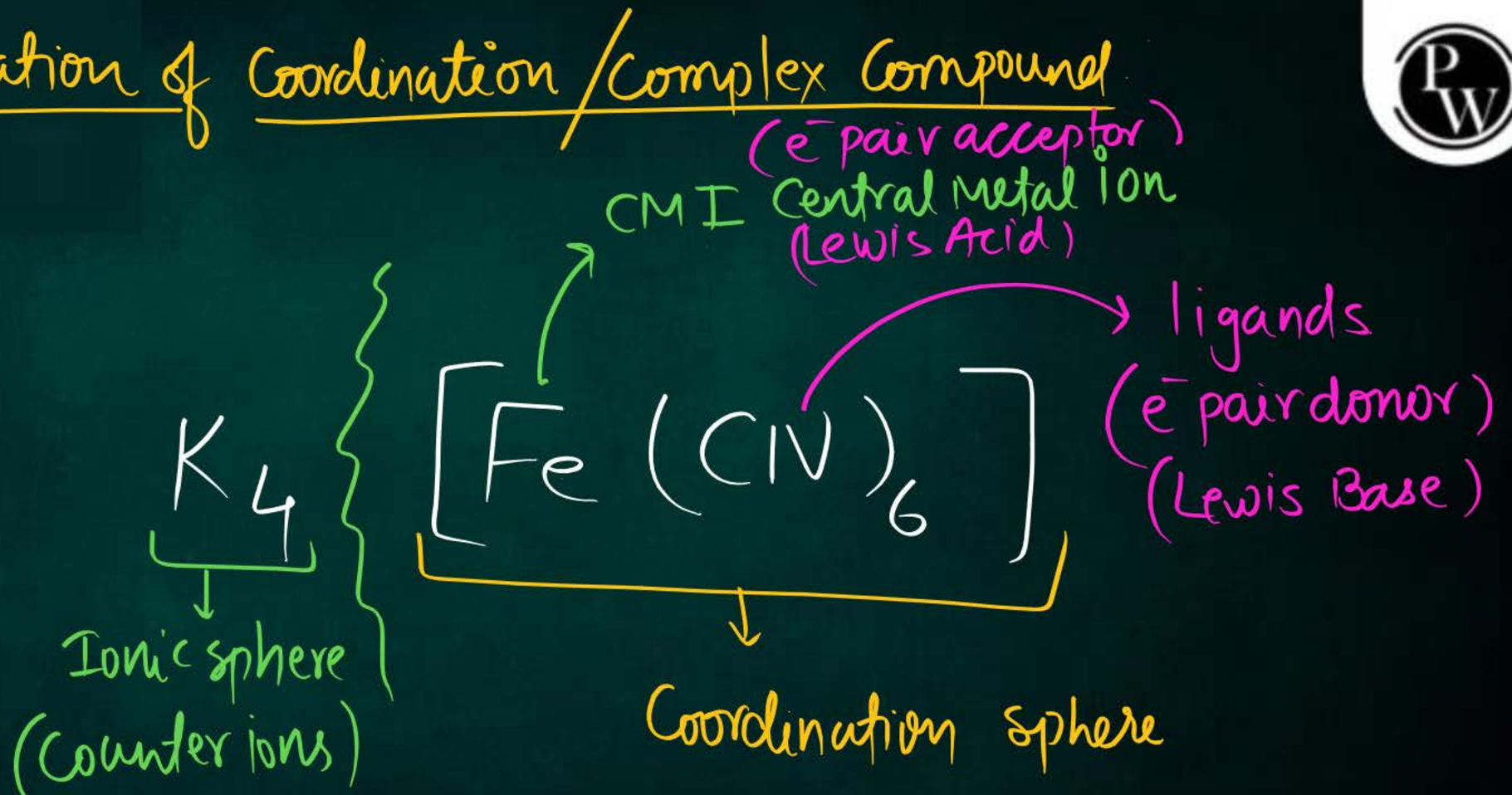
Test of Cu^{2+} ions ~~X~~

Test of SO_4^{2-} ✓✓

$BaCl_2$

$BaSO_4$ ↓ White ppt

Representation of Coordination / Complex Compound



$[ML_n]^0$

Neutral Complex

gen. water insoluble

w/i

$X^+ [ML_n]^-$

X^+ → Counter Cation (Normal ion)

$[ML_n]^-$ → Complex anion (anionic Complex)

$[\quad]^+ X^-$

$[\quad]^+$ → Complex Cation

X^- → Normal anion (Counter)

$[\quad]^+ [\quad]^-$

$[\quad]^+$ → Complex Cation

$[\quad]^-$ → Complex anion

Definitions of Some Important Terms Pertaining to Coordination Compounds

NCERT

(CMI)

(a) **Coordination entity :** Constitutes a central metal atom or ion bonded to a fixed number of ions or molecules (ligands). These are enclosed in square bracket which is known as **coordination sphere**.

$[M L_n]$

(b) **Central atom/ion :** Lone pair acceptor

Generally referred to as Lewis acid

(c) **Homoleptic complexes :** Complexs in which CMI is bound to only one kind of ligands.

Ex $K_4[Fe(CN)_6]$ $[CoF_6]^{3-}$

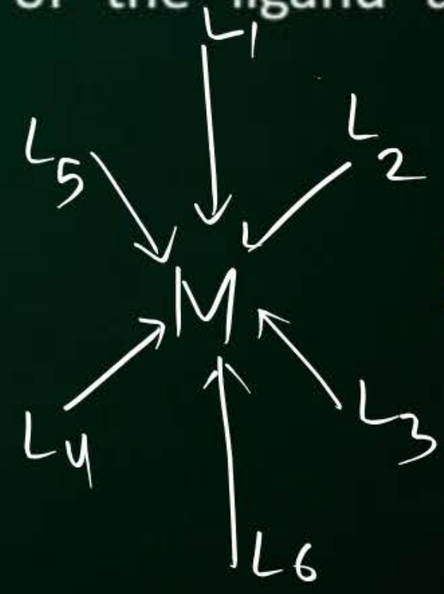
(d) **Heteroleptic complexes :** Complexs in which CMI is bound to more than one kind of ligands.

$[Pt(NH_3)_4Cl_2]Cl_2$

(e) **Coordination polyhedron :** Spatial arrangement of the ligand atoms around CMI.

geometry / shape of dabba

Ex $[ML_6]$



octahedral

- linear
- T. Planar
- *tetrahedral
- *Sq. Planar
- T. Bipyramidal
- *Octahedral (most imp)

Q Why d Block Metals Form more no of Complexes :- ?

(1) They Can show Variable O.S

(2) They have Small size

(3) They have High Charge density (ϕ)

$\phi \propto \frac{\text{Charge}}{\text{radius}}$

(4) They have Vacant d-orbitals

(2, 3, 4) Correct Ans

Conditions to Form Coordinate Compounds (Complex Comp.)

(i) Size of CMI must be Small ($r^+ \downarrow$)

(ii) Charge on CMI must be High (High ϕ) $q^+ \uparrow$

$r^+ \downarrow$ $q^+ \uparrow$

These two Condition will Promote Covalent nature in Bond Between CMI & ligand

(iii) CMI must have Vacant orbital

To accept e^- pair From ligands to to Form Coordinate (Dative) type of Bond

Q True / False about $[Co(NH_3)_5Cl]SO_4$.

(i) Homoleptic complex. (F)

(ii) give test of Cl^- ion. (F)

(iii) give test of SO_4^{2-} on reaction with $BaCl_2$ (T)

(iv) Counter ion is Cl^- & SO_4^{2-} (F)

(v) show Electrical Conductivity. (T)

(vi) Counter ion is bivalent. (T)

$[\ ]^{2+}$ SO_4^{2-} ions present

THANK YOU

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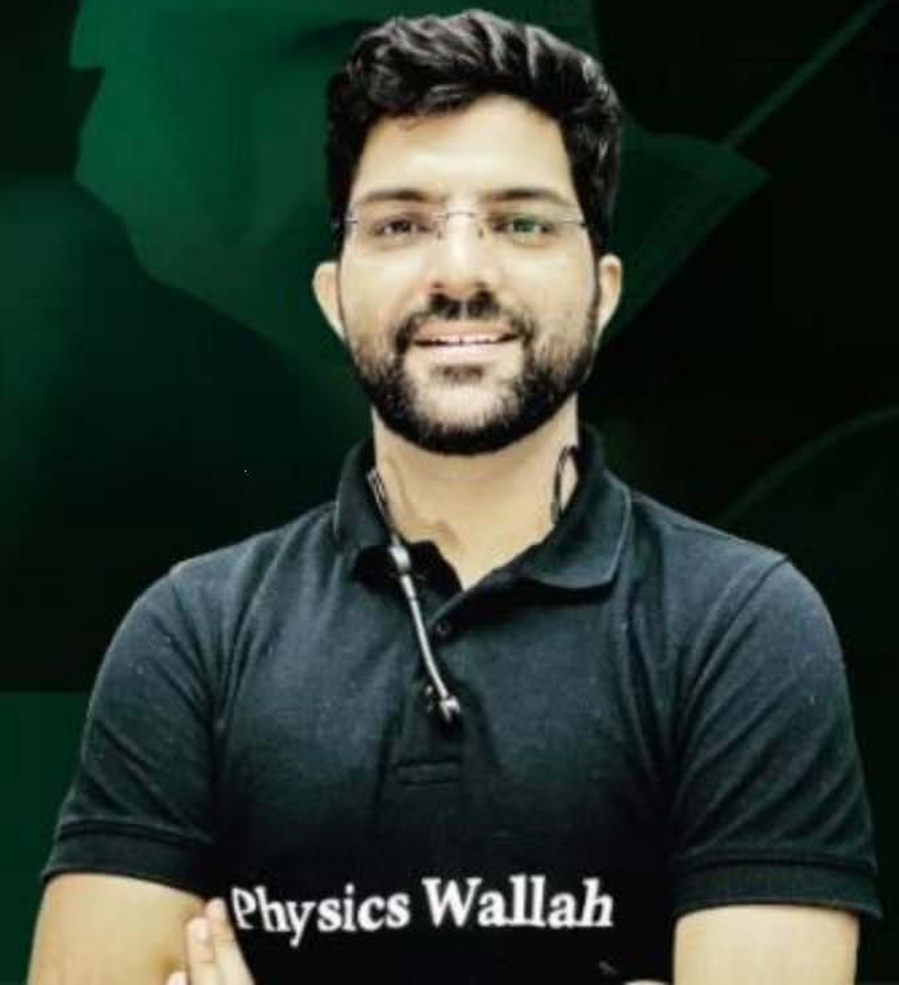
Lecture - 02 | Inorganic Chemistry

Coordination Compounds



By - Mohit Dadheech (MD Sir)

Topics *to be covered*

1. ligands
2. O.N & C.N. of CMI

ML_6

$[M(L_n)]$

ligands

Charge

Anionic ✓

neutral ✓

Cationic

L → M

denticity → no. of e⁻ pair donate by single unit

d = 1 (monodentate)

d = 2 bi/didentate

d = 3/4/5/6 polydentate

1,2 diamine ethane

ethylenediamine

Ligands : Molecules/ions capable of donating e^- pairs to CMI.

Denticity : Number of e^- pairs which can be donated by a ligand to metal ion simultaneously.

or

no. of σ coordinate Bonds Formed by a single Unit of ligand simultaneously

Classification of Ligands :

On the Basis of charge

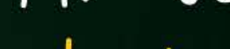
- Anionic (suffix "-o")
- Neutral
- Cationic

On the Basis of denticity

- Monodentate
- bi/didentate
- polydentate:
  - tri
  - tetra
  - Penta
  - Hexa

Based on e^- donation/acceptance

- Classical ligands donate to CMI



- Non classical ligands donate as well as accept from CMI

Some Imp. ligands :-

Anionic → Suffix - O

1. CO_3^{2-} Carbonato
2. SO_4^{2-} Sulphato
3. F^- Fluorido
4. Cl^- Chlorido
5. Br^- Bromido
6. I^- Iodido
7. OH^- Hydroxido
8. O^{2-} Oxido
9. O_2^{2-} Peroxido
10. O_2^- Superoxido
11. NH_2^- Amido
12. NH^{2-} Imido
13. N^{3-} Nitrido
14. N_3^- Azido
15. S^{2-} Sulphido
16. SO_3^{2-} Sulphito

17. CN^- Cyanido

18. NC^- Isocyanido

19. NO_2^- Nitrito-N or nitro-N

20. ONO^- Nitrito-O nitro-O

21. SCN^- Thiocyanato or thiocyanato-S

22. NCS^- Isothiocyanato or Thiocyanato-N

23. OCN^- Cyanato or Cyanato-O

24. NCO^- Isocyanato or Cyanato-N

17th to 24 → Ambidentate ligands

25. Oxalato (ox) $C_2O_4^{2-}$

COOH
|
COOH
$\downarrow -2H^+$
COO^-
|
COO^-
Oxalate ion

denticity → 2
didentate

5 M Ring Present

donor atoms → Same (2)
Both are "O"

Symmetrical Bidentate ligand

26. Glycinato (gly^-)

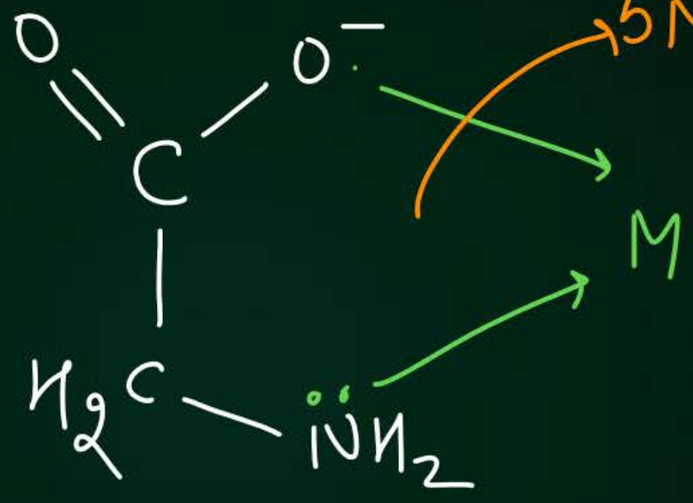
glycine

NH_2CH_2COOH

$\downarrow -H^+$

glycinate

$NH_2CH_2COO^-$



5M Ring

Bidentate ($d=2$)

donor atoms - (2)

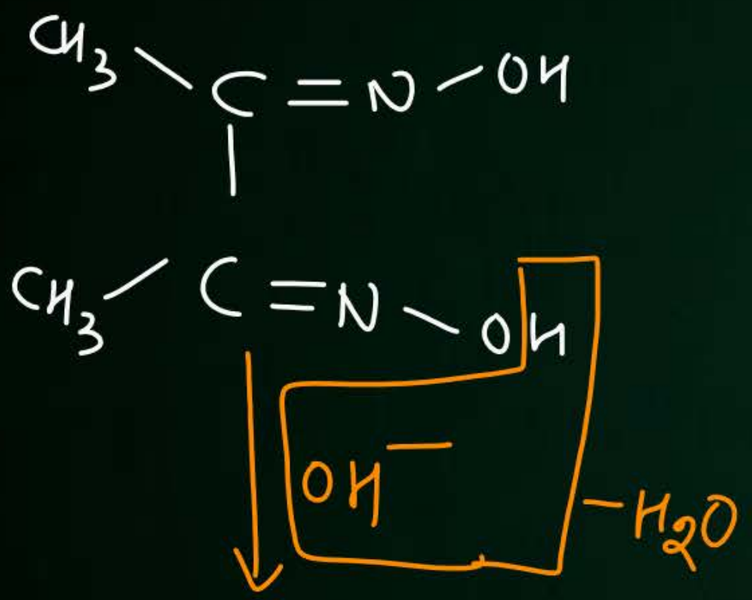
1 O + 1 N

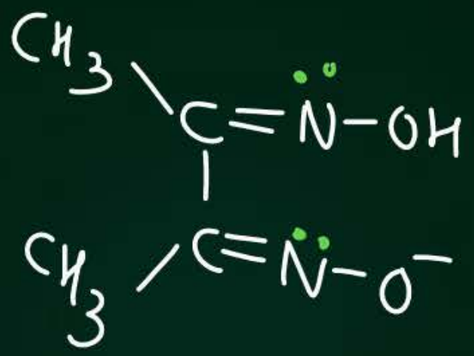
donor atoms diff

↓

Unsymmetrical Bidentate

27. dmg^- (dimethylglyoximato)

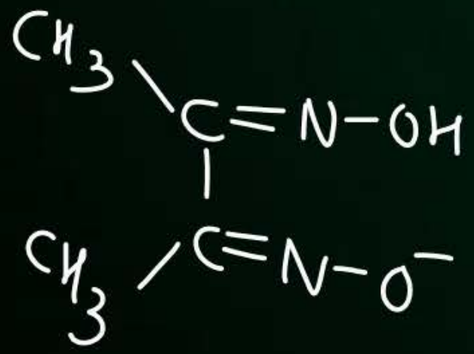




Two "N" → donor atoms

dicentate

* Used in test of Ni^{2+} & Pd^{2+} ions



dimethylglyoximate

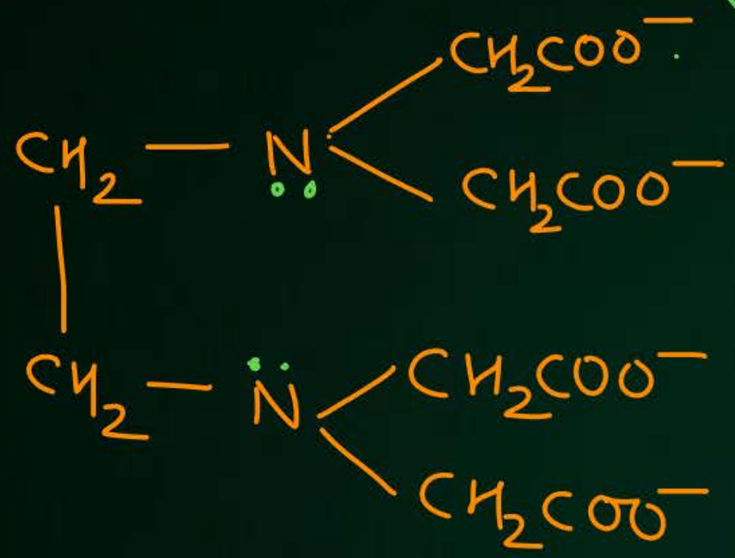
(28) $edta^{4-}$ ethylene diamine tetraacetato.

2 "N" + 4 "O" donors ⇒ 6 donors

↓

Hexadentate

$d = 6$



Q How many edta molecules are req. to form octahedral Complex with metal ion :—

(1) 6

(2) 3

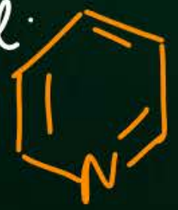
(3) 4

(4) 1 ✓

6 σ Coordinate Bonds ← $d=6$

Some imp Neutral ligands :-

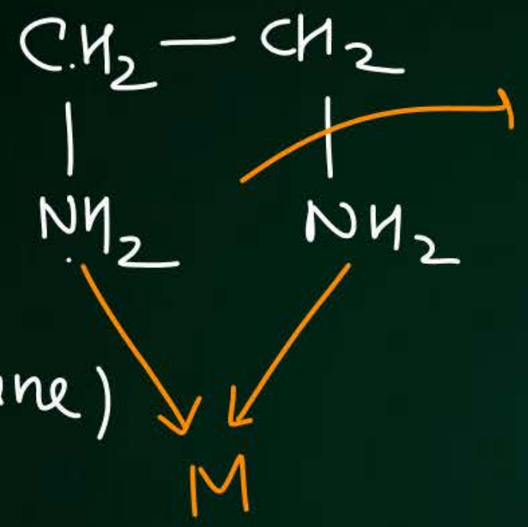
1. NH_3 Ammine
2. H_2O Aqua.
3. CO Carbonyl.
4. NO Nitrosyl.
5. PH_3 phosphine
6. PPh_3 triphenyl phosphine
7. py Pyridil / pyridine.



8. en ethylene diamine $d=2$
9. bn butylene diamine $d=2$
10. pn propylene diamine $d=2$
11. tn trimethylene diamine $d=2$
12. dien diethylene triamine $d=3$
13. trien triethylene tetraamine $d=4$
14. dipy. dipyridil / dipyridine. $d=2 \rightarrow$ (N)

donor (N)

en ethylene diamine



(1,2 diamine ethane)

5M Ring.

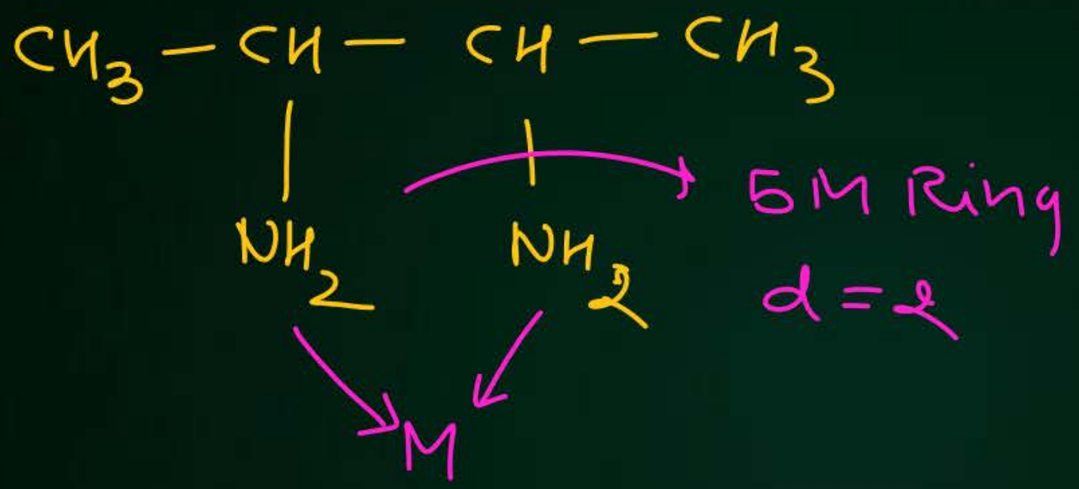
d = 2

Bidentate.

donor atoms → two "N"

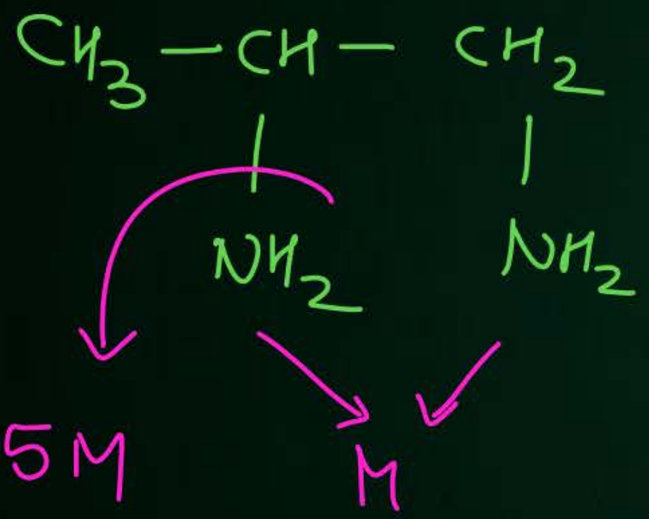
bn

Butylene diamine



pn

1,2 diamine propane.

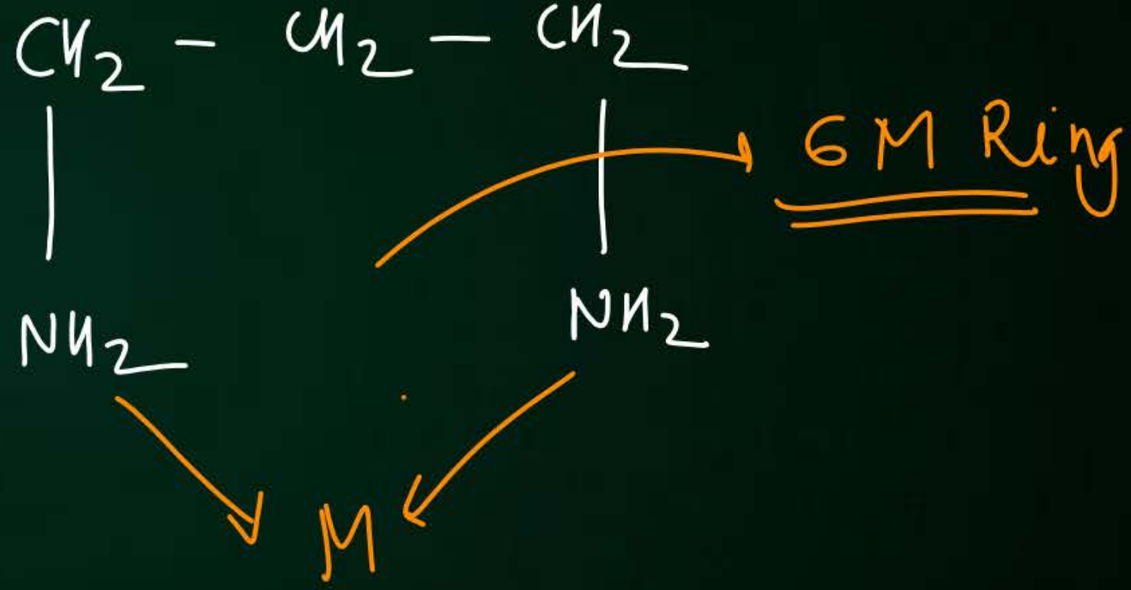


Ring.

donor atoms - two "N"

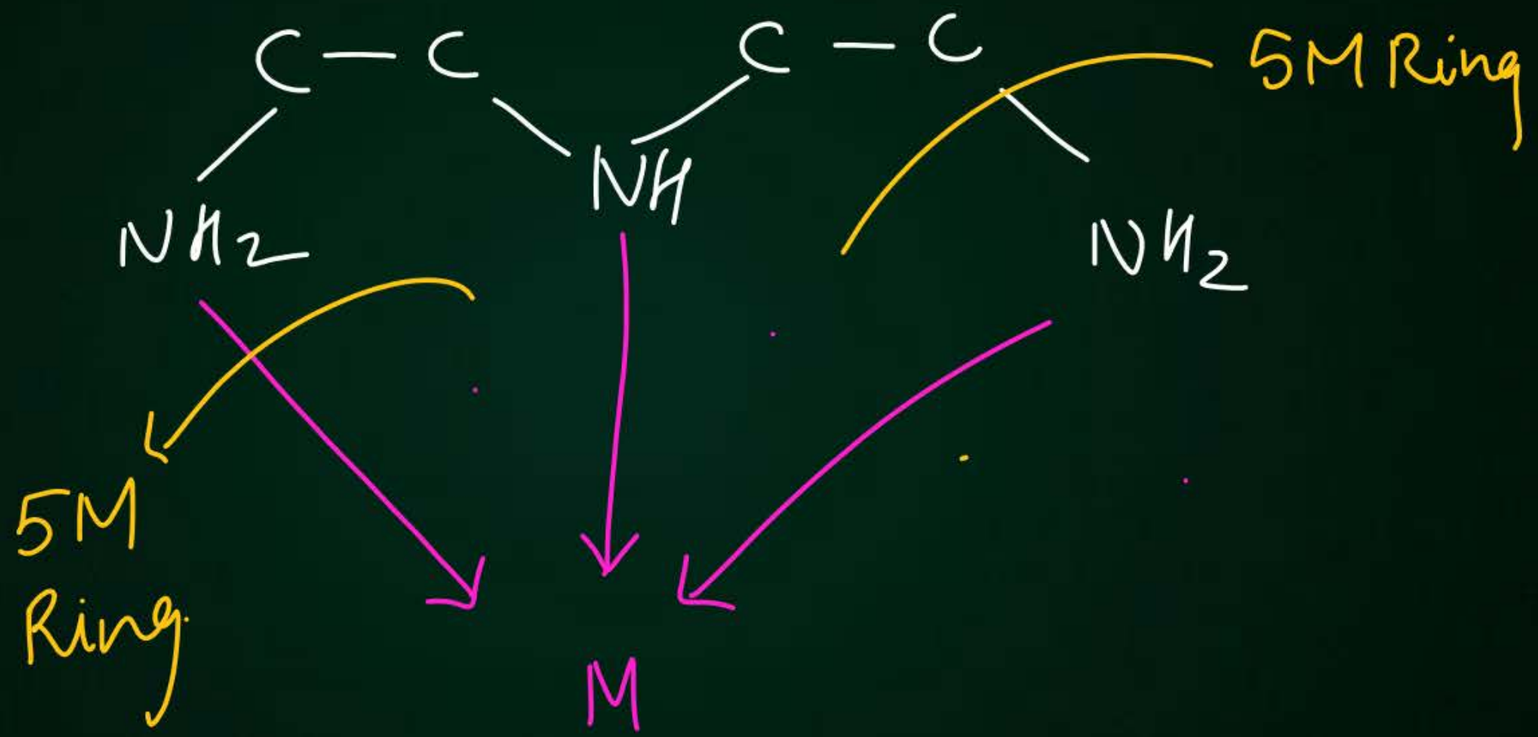
tn

1,3 diamine propane.



dien diethylene triamine.

↳ 3 'N' donor atoms

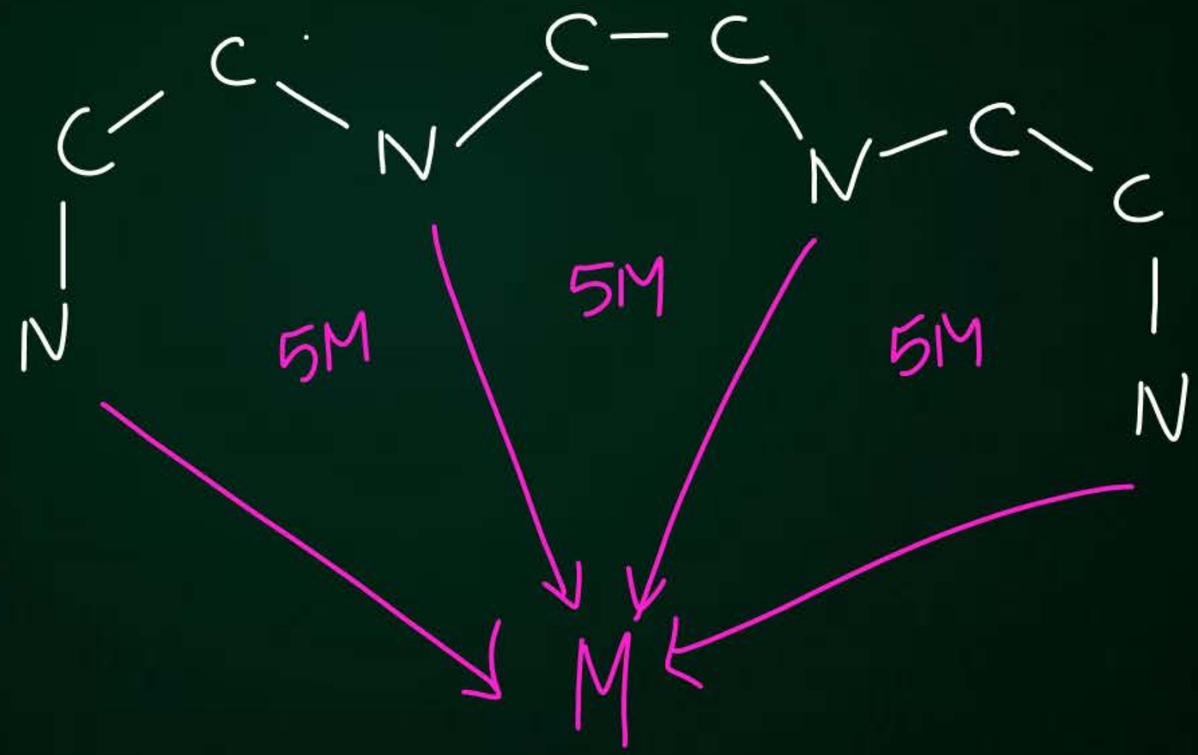


trien

triethylene tetraamine

4 "N" donor atoms.

total Rings → ③



Cationic ligands

(1) NO^+ · Nitrosonium / nitrosylium

2. $NH_3-NH_2^+$ Hydrazinium

* Ambidentate ligands

Those ligands which have more than one donor atoms but all are not Functional Simultenously.

These ligands have diff CMI & donor atom linkages.

Ex CN^-, NO_2^- - - - etc.

Chelate ligands :-

~~d = 1~~

d = 2 or more

* ligands which form rings when attached to CMI.

* For ring formation denticity must be more than one

Ex dmg$^-$ en
edta^{4-} bn
$C_2O_4^{2-}$ tn
gly$^-$ pn
dien - - - etc.

Flexidentate ligands :-

ligands which can show Variable denticity.

CO_3^{2-} → 1*/2 (*Mainly → 1)

SO_4^{2-} → 1*/2

edta → 1/2/3/4/5/6*

Coordination number : Number of ligand donor atoms to which metal is directly bonded.

OR

coordination number is equal to number of 6 bonds present between ligand & CMI.

geometry of complexes decided by C.N.

C.N. = 6

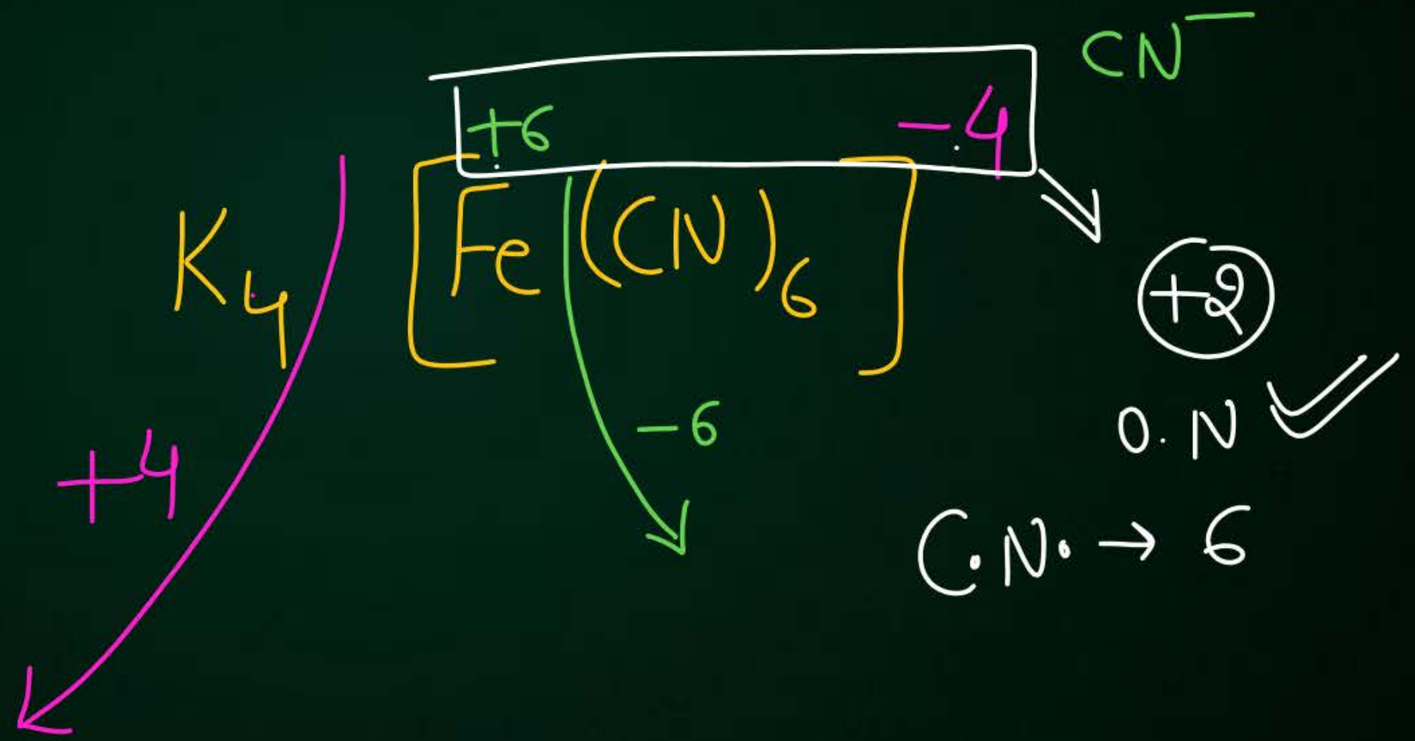
$(CN)_6$

$(en)_3$

Oxidation number of central atom : Charge present on CMI if all the ligands are removed along with their electron pairs.

#MDJ

O.N of CMI → Metal Ke Andar Kacharge & dabbe par charge Ka Final Hisaab.



② $[Cu(NH_3)_4]SO_4$

0 +2 → +2

O.N.

0 −2

C.N. ⇒ 4

③ $[Co(en)_3]$

0 3+ → +3

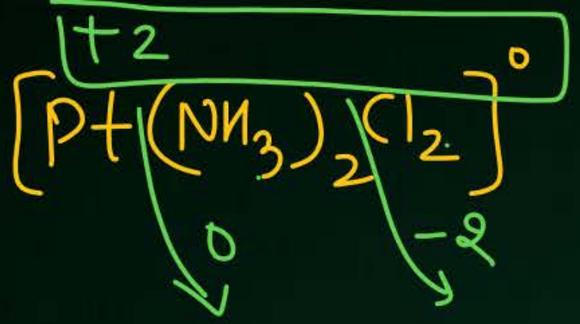
O.N.

C.N. = ~~3~~

en(d=2)

C.N. = 6

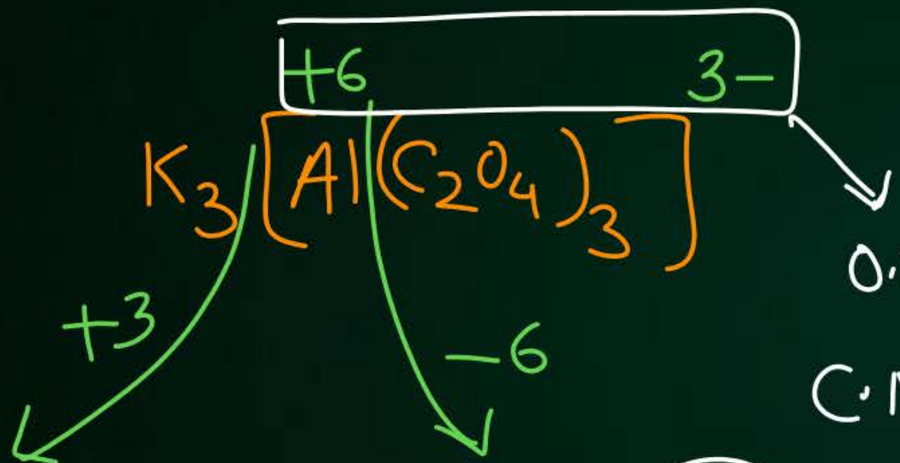
(4.)



O.N = +2

C.N. = 4

(5)



O.N = +3

C.N. = 6

~~8~~

$C_2O_4^{2-}$

$d = 2$

Homework :- Find O.N & C.N of CMI in following –

(1.) $[Co(NH_3)_3(NO_2)_3]$

(2.) $[Co(NH_3)_6]^{3+}$

(3.) $[Ni\,Cl_2(PPh_3)_2]$

(4.) $[Cr\,Cl_2(ox)_2]^{3-}$ (ox ⇓ (oxalato))

(5.) $[Co(NH_3)_5CO_3]Cl$

(6.) $[Pt(gly)_2Cl_2]^{2+}$

(7.) $[Ni(dmg)_2]$

(8.) $[Cr(Py)_3Cl_3]$

(9.) $[Sc(H_2O)_3(NH_3)_3]^{3+}$

(10.) $[Ti(en)_2(NH_3)_2]^{4+}$

(11) $[Rh(PPh_3)_3Cl]$

(12.) $[Co(en)_2Cl_2]Cl$

THANK YOU

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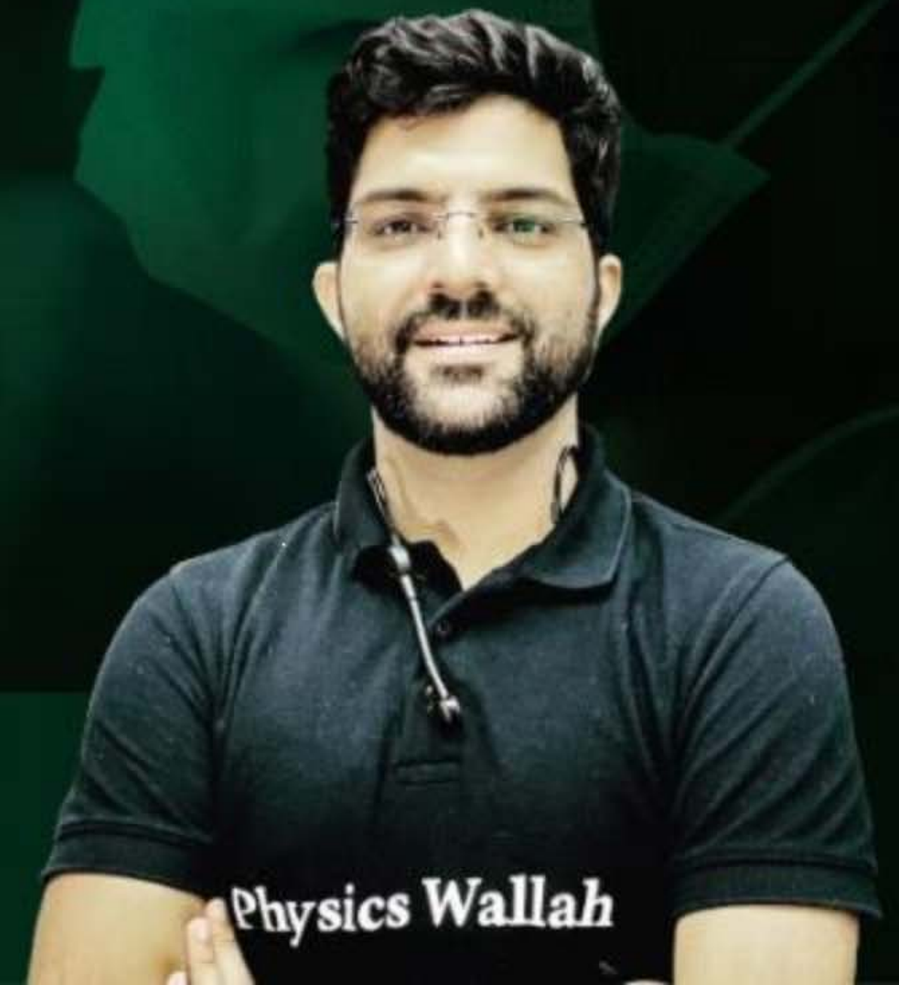
FOR NEET 2025

Lecture -03 | Inorganic Chemistry

Coordination Compounds



By - Mohit Dadheech (MD Sir)

Topics *to be covered*

1. Some other imp ligands
2. EAN Rule

Homework :- Find O.N & C.N of CMI in following -

(1.) $[Co(NH_3)_3(NO_2)_3]$ — $+3$, 6

(2.) $[Co(NH_3)_6]^{3+}$ — $+3$, 6

(3.) $[NiCl_2(PPh_3)_2]$ — $+2$, 4

(4.) $[Cr(Cl_2)(Ox)_2]^{3-}$ (Ox = Oxalato) — $+3$, 6

(5.) $[Co(NH_3)_5(CO_3)]Cl$ — $+3$, 6

(6.) $[Pt(Cl_4)(Cl_2)]$ — $+4$, 6

(7.) $[Ni(dmg)_2]$ — $+2$, 4

(8.) $[Cr(Py)_3(Cl_3)]$ — $+3$, 6

(9.) $[Sc(H_2O)_3(NH_3)_3]^{3+}$ — $+3$, 6

(10.) $[Ti(en)_2(NH_3)_2]^{4+}$ — $+4$, 6

(11) $[Rh(PPh_3)_3Cl]$ — $+1$, 4

(12.) $[Co(en)_2Cl_2]Cl$ — $+3$, 6

Some other imp organic ligands :—

(π e^- donors)

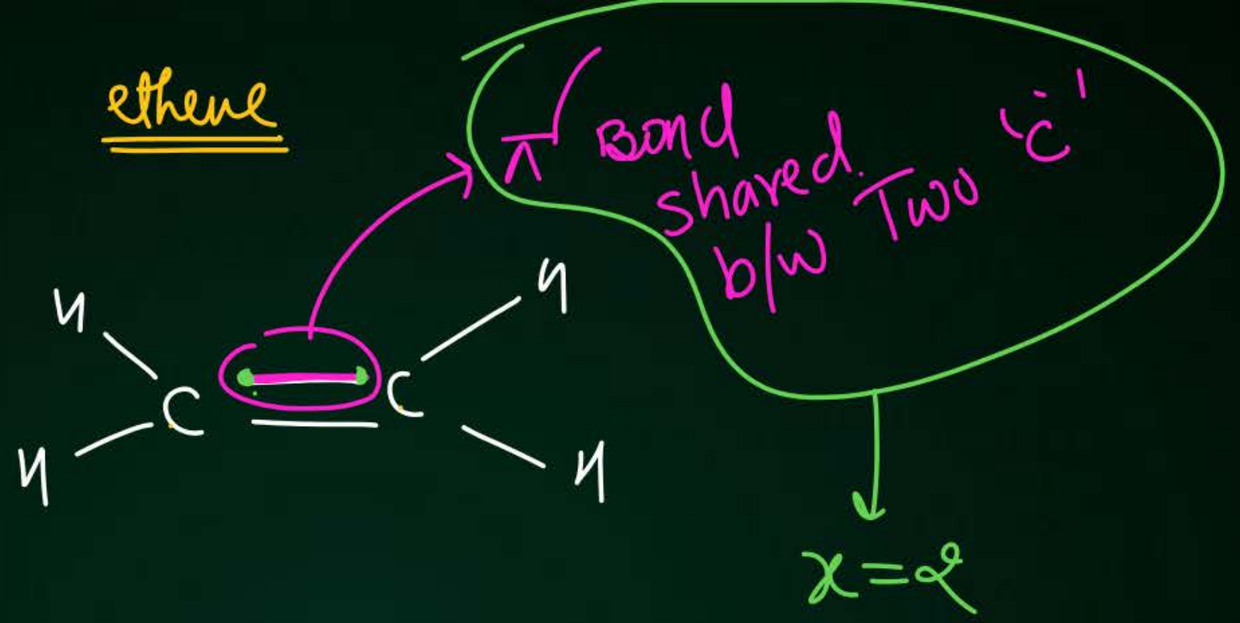
* ~~dentic~~ city Hepticity ✓

(η)

η^{x}

x = no. of atoms in which π e^- density is shared.

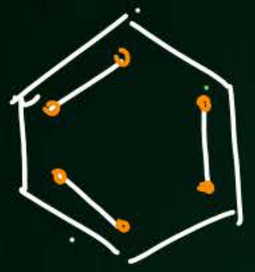
(1) $CH_2=CH_2$ ethene



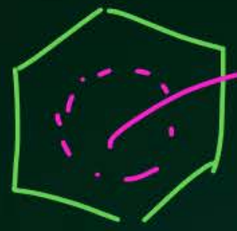
Name → η^2-ethene

2 πe^- donor

(2) C_6H_6



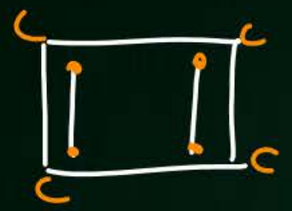
$\pi = 6$



$6\pi e^-$ donor

η^6 - Benzene

(3) C_4H_4



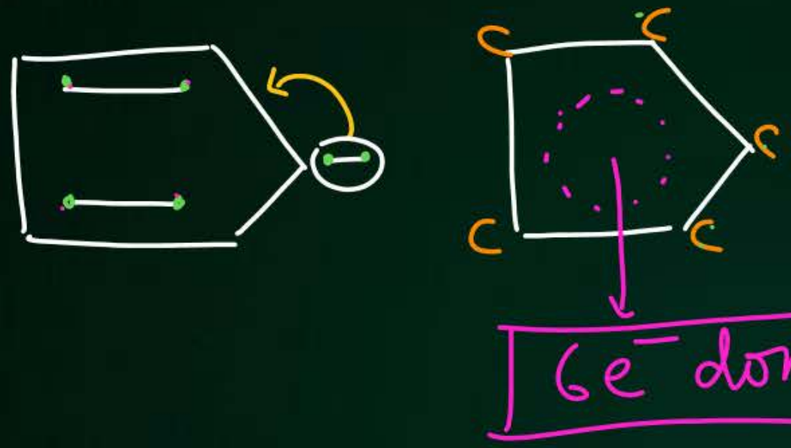
$x = 4$ → 4 carbons

η^4 - cyclobutadien

4 e^- donor.

④ $C_5H_5^-$

π donor



6 e^- donor

Anionic — Suffix → enyl

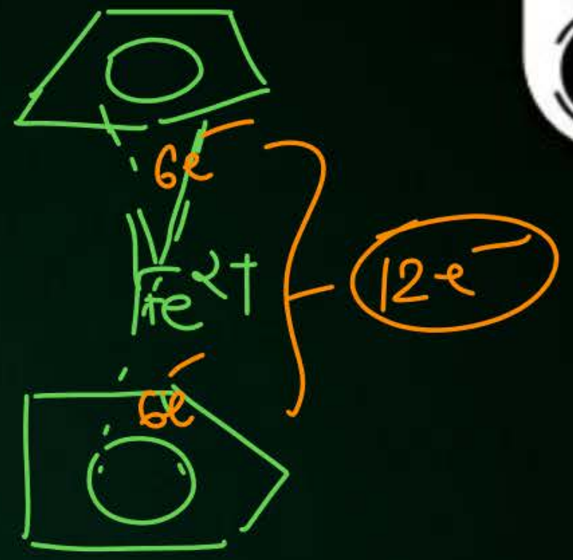
η^5 - Cyclopentadienyl

NOTE $C_5H_5^-$ also work as 2 e^- donor (σ donor)

→ 2 e^- donor

~~η^5~~ Cyclopentadienyl.

$[Fe(C_5H_5)_2]$ Ferrocene



$K[PtCl_3(C_2H_4)]$ Zeise's salt.

E.A.N. Rule (Sidgwick Rule)

Effective atomic Number

no. of $\bar{e}$ present into orbitals of metal after Complex Formation.

#MDJ

E.A.N & CMI = Kya Khoya, Kya Paya.

EAN of CMI = Z of CMI − O.N of CMI + e^- gained from ligands.

* according to Sidgwick CMI in complexes tends to achieve (EAN) no. of e^- equal to atomic no. of next inert gas.

$K_4[Fe(CN)_6]$ (Fe^{2+})

$26 - 2 + 12e^- \Rightarrow 36$

EAN =

* Sidgwick explains stability of some complexes on the basis of EAN (Mainly in Metal Carbonyls)

(2) $[Ni(CO)_4]$ Ni^0

$28 - 0 + 8 = 36$ EAN Rule ✓

From 4 CO

$4 \times 2 = 8e^-$

(3) $[V(CO)_6]^0$

Work as O.A

$23 - 0 + 12 = 35$ (EAN not followed)

$[V(CO)_6] + 1e^- \longrightarrow [V(CO)_6]^-$

$23 - (-1) + 12 = 36$ ✓

④ $[Mn(CO)_5]^{\circ}$

$25 - 0 + 10 = 35$ (EAN not Followed)

$[Mn(CO)_5] + e^- \longrightarrow [Mn(CO)_5]^-$

(O·A)

$[25 - (-1) + 10]$

36 ✓

Note $Mn(CO)_5$ stabilize by follow EAN Rule :—

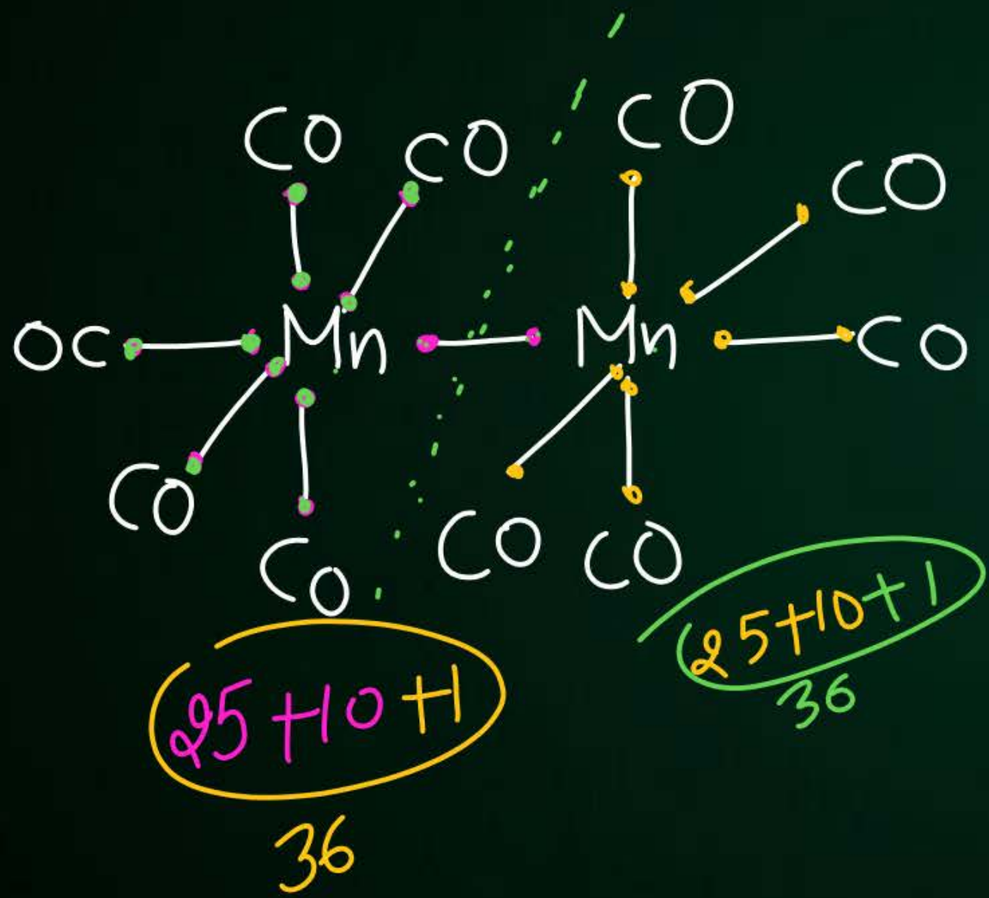
(i) work as O·A ✓

(ii) By dimerisation

$$[Mn(CO)_5] + [Mn(CO)_5] = [Mn_2(CO)_{10}]$$

EAN = 36 ✓

EAN Followed.



By formula

$$(25 \times 2) - 0 + (10 \times 2) + 2$$

$$50 + 20 + 2 = 72$$

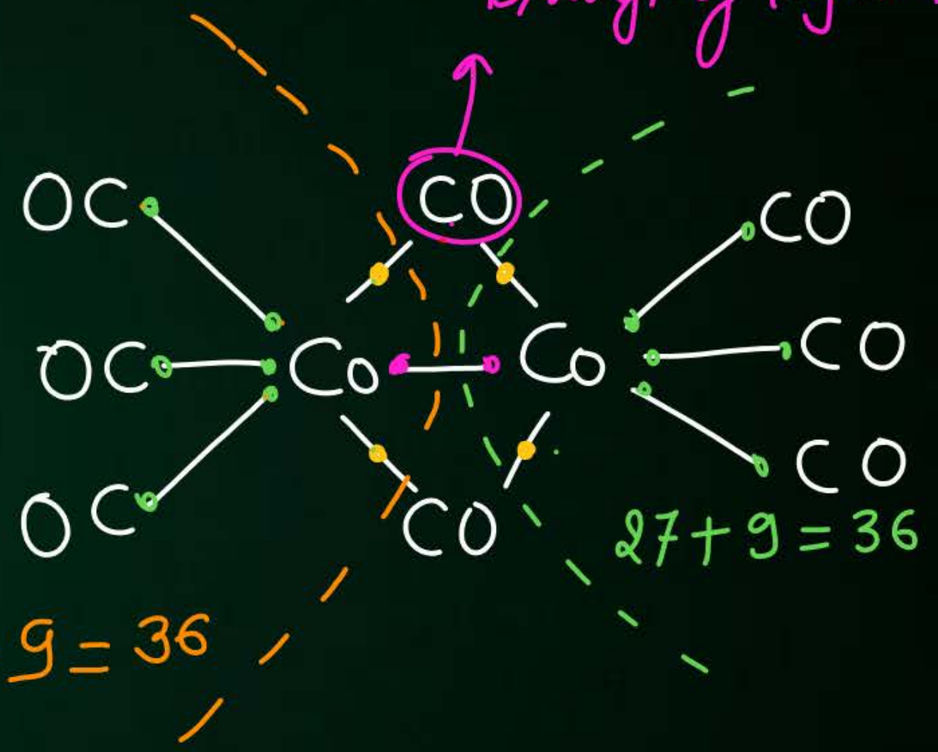
$$\frac{EAN}{\text{of CMI}} = \frac{72}{2} = 36$$

$[Co_2(CO)_8]$

$27 \times 2 - 0 + (8 \times 2) + 2$

$54 + 16 + 2 = 72$

EAN of Co $\Rightarrow \frac{72}{2} = 36$



Z of Co = 27

$[Mn(CO)_6]$

$25 - 0 + 12 = 37$

$[Mn(CO)_6] \xrightarrow{-e^-} [Mn(CO)_6]^+$

(R.A)

$25 - 1 + 12 = 36$

NOTE

NO is a 3 e^- donor.

$[Cr(CO)_6]$ How many NO are required to replace all CO ligands.

$6 \times CO \Rightarrow 12e^-$ NO → 3 e^- donor.

(4 NO Required)

Ferrocene

$[Fe(\pi\text{-}C_5H_5)_2]$

$C_5H_5^-$ π-donor ($6e^-$ donor)

Fe^{2+}

$26-2+(6\times2)$

$24+12=36$

Zeise's Salt :-

$K[Pt(Cl_3)(C_2H_4)]$

$+1$, Pt: $+3$, Cl_3: -3, (C_2H_4): -1 $= +2$

$[78-2+8]$

84

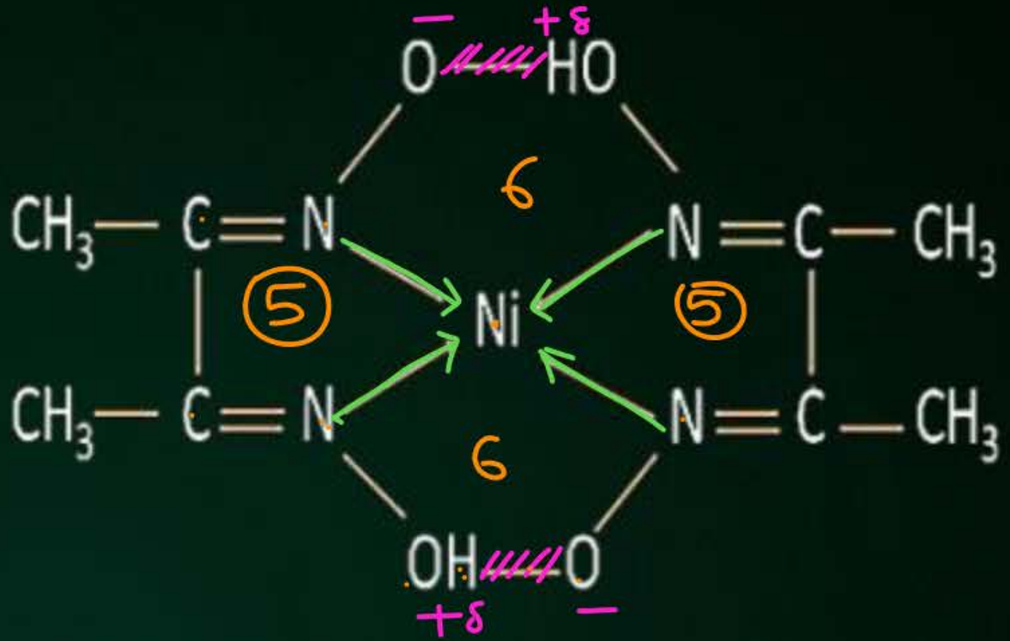
C_2H_4

η^2 - ethene

$2e^-$ donor

(24) dmg^- (dimethyl glyoximato)

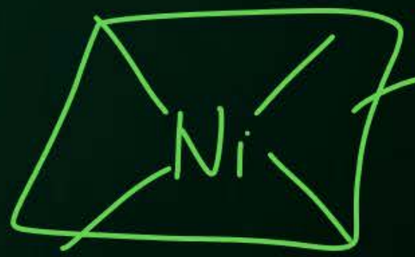
$$Ni^{+2} \xrightarrow[NH_4OH]{dmg} \boxed{Ni(dmg)_2 \text{ (Cherry red ppt)}}$$



Nickel dimethylglyoxime complex

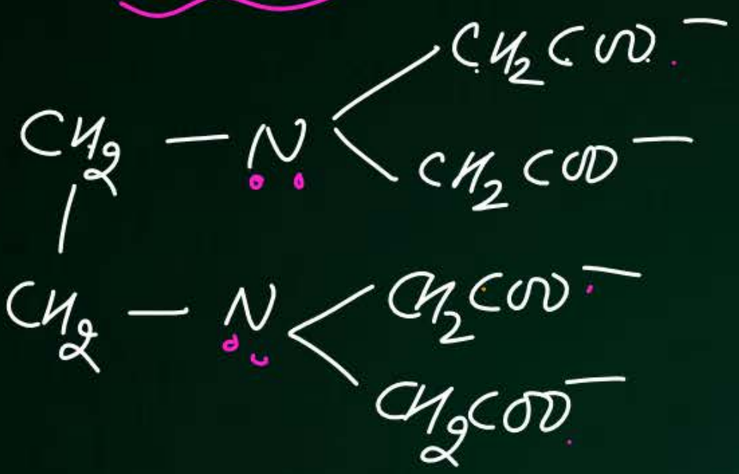
Imp. points about Complex :–

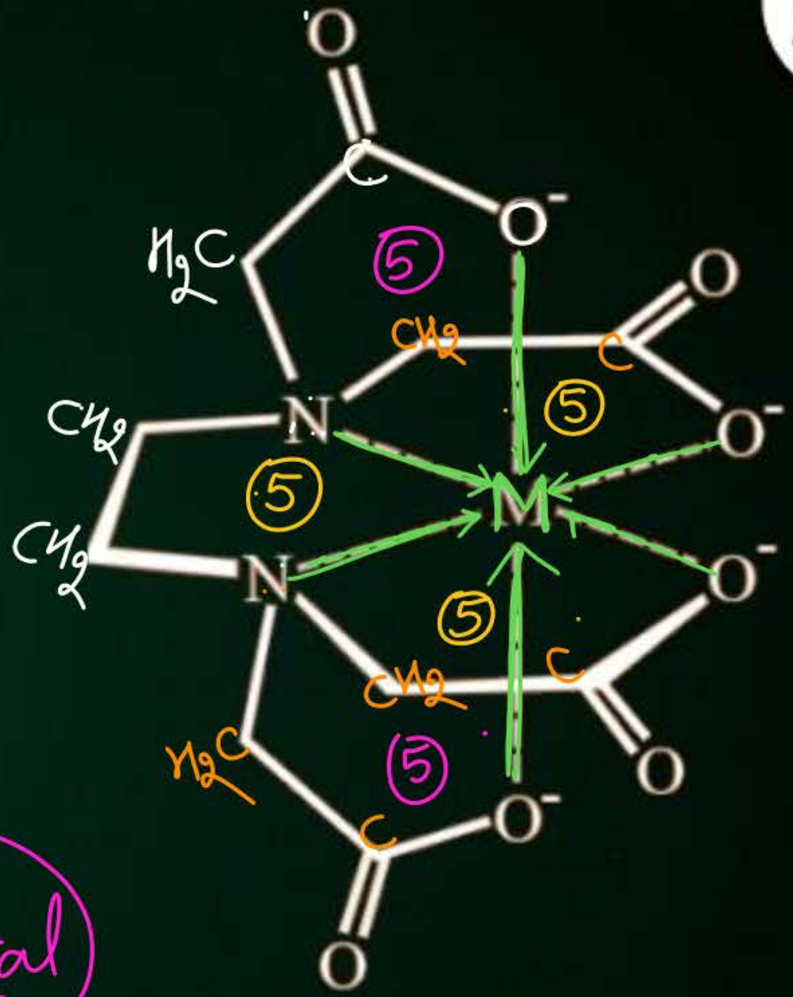
- Sq. planar Complex., Ni is dsp^2 Hybridised.
- Optically Inactive (POS)
- → No of Rings = 4 (two 5 M + two 6 M)
- Symmetrical H-Bonding Present
  - → dimerisation (stable)
- Coordination no. of Ni ⇒ 4
- Neutral complex. ∴ Water insoluble → Red ppt



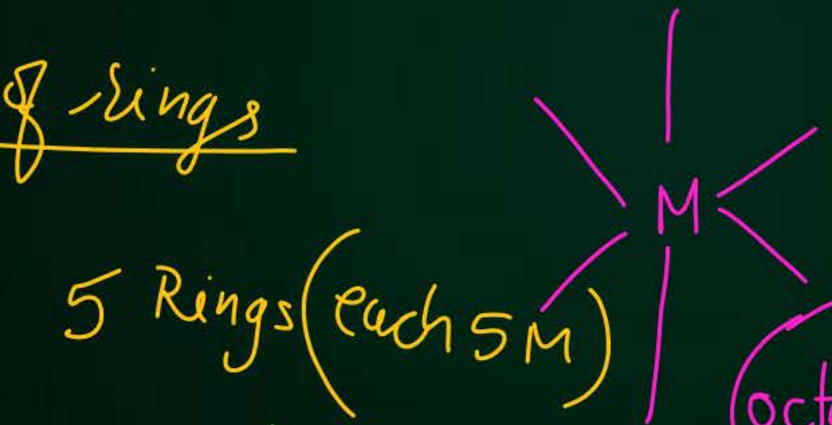
→ Sq. planar dsp^2

$(EDTA)^{4-}$ (Ethylene diamine tetra acetato)





Total no. of rings



5 Rings (each 5M)

octahedral
C.N. = 6

Non-coplanar rings present → optically active

Imp Uses of edta Complexes

(i) Used to treat Pb poisoning.

(ii) In water Hardness estimation.

Homework: Find E.A.N For For following Complexes :-

① $Fe(CO)_5$

② $[Cr(C_6H_6)_2]$

③ $[Fe_2(CO)_9]$

④ $[NiCl_4]^{2-}$

⑤ $[Ti(\sigma C_5H_5)_2(\pi C_5H_5)_2]$

THANK YOU

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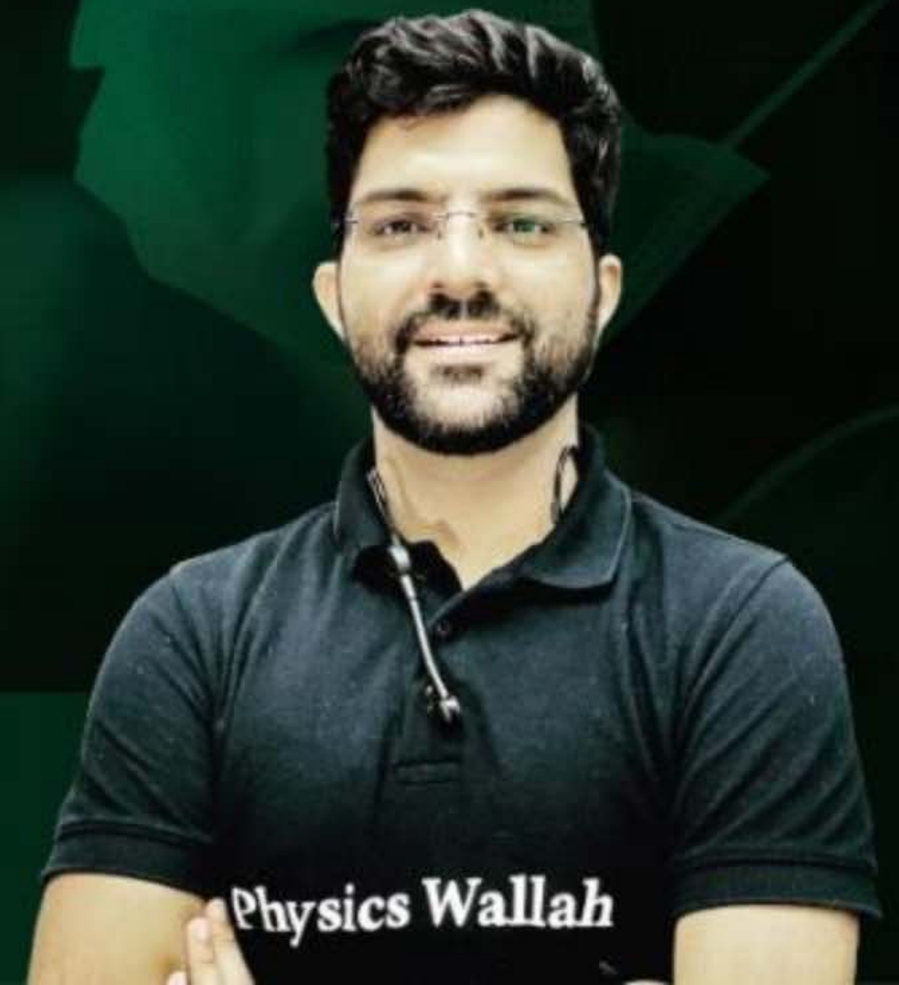
FOR NEET 2025

Lecture - 04 | Inorganic Chemistry

Coordination Compounds



By - Mohit Dadheech (MD Sir)

Topics *to be covered*

1. Bonding in Metal Carbonyls (Synergic Bonding)

(3) Classification based on electrons donation/acceptance :

Classical

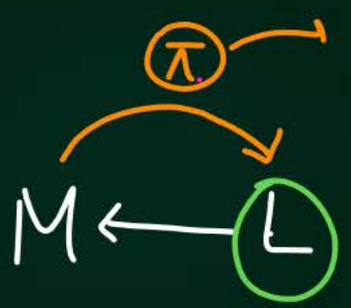
$M \leftarrow_{\sigma} L$

Ex F^-, NH_3, OH^- ... etc.

Non-Classical

- π Acid ligands
- Imp. Ex. : $CH_2 = CH_2$, CO, CN^-, C_6H_6 etc.

Imp. given in NCERT



π Coordinate Bond.
(Back Bond)
Back donation.

Form π Bond By accepting e^- From Metal.
∴ Known as π- Acid ligands.

e^- pair accept Lewis Acid

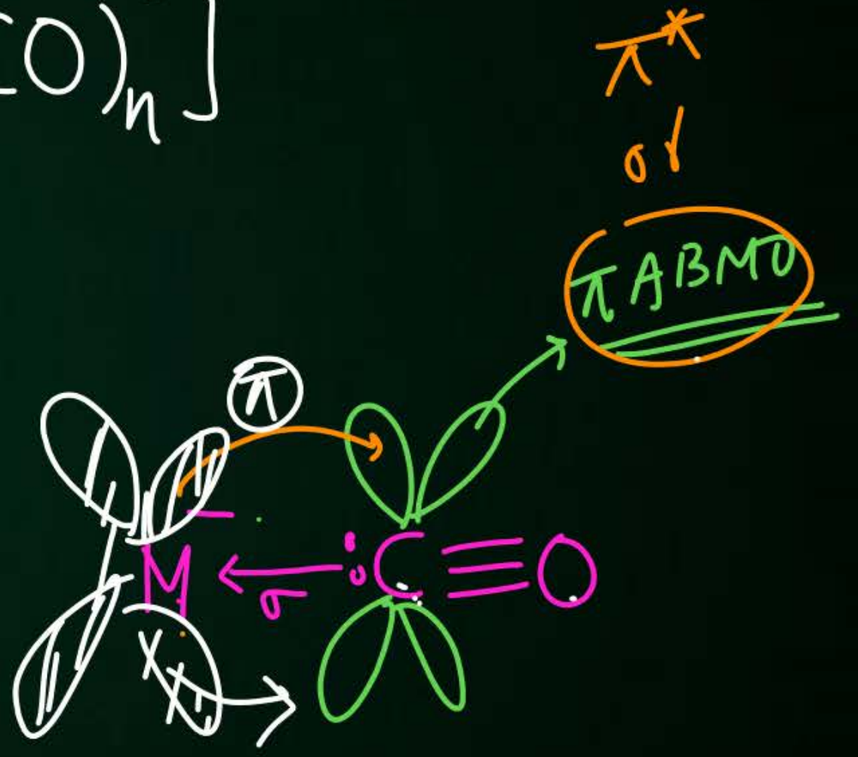
Bonding in Metal Carbonyls :-

$[M(CO)_n]^+$ $[M(CO)_n]^0$ $[M(CO)_n]^-$

Extent of Synergic Bonding

$M^+ < M^0 < M^-$

Extent of Synergic Bonding $\propto$ $\bar{e}$ density on CMI

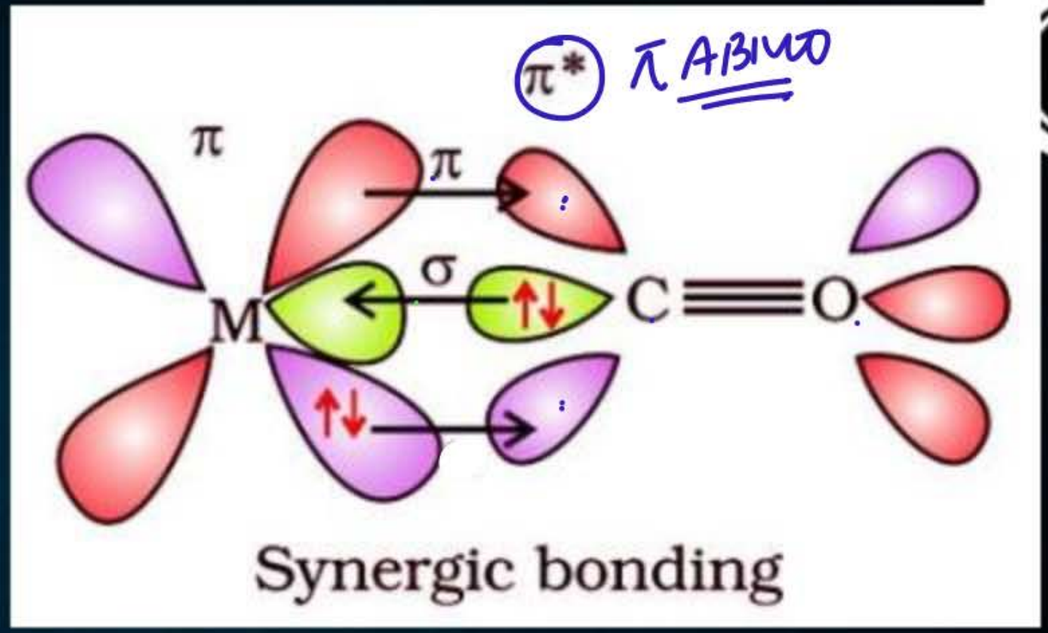


Bonding in Metal carbonyls

Imp. Points

① In Metal Carbonyls M–C Bond have Both σ & π character.

Ⓐ σ Bond is formed by overlapping of Filled orbital of CO & Vacant orbital of Metal



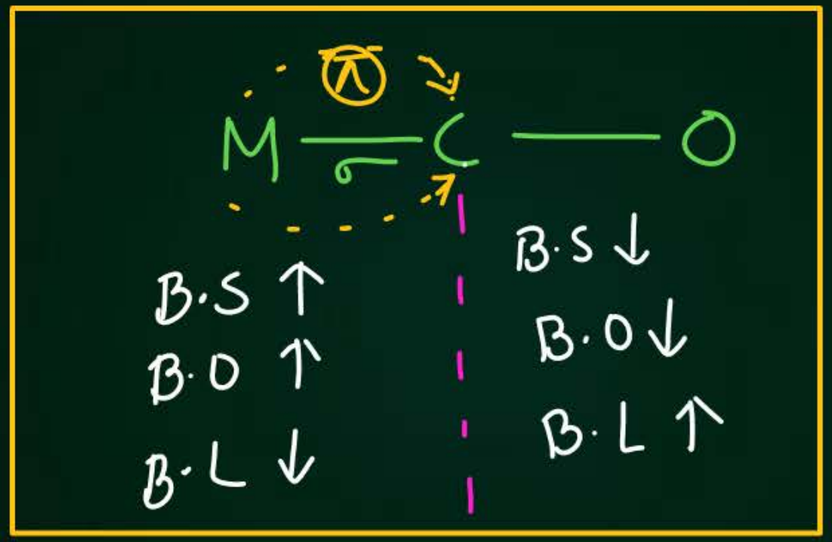
Synergic bonding

Ⓑ π Bond is formed by overlapping of Filled "d" orbital of Metal & Vacant Anti Bonding orbital of CO (π-ABMO)

(Back donation / Back Bonding / synergic Bonding

② due to accepting $\bar{e}$ in π ABMO.

Internal B.O of CO (C—O B.O) ⇒ ↓se and C—O B.L ⇒ ↑se
(only 2–5% ↑se)



③ Synergic Bonding Stabilize Metals in their Lower O.S
(π-acid ligands stabilize Lower O.S of Metals)

QUESTION

Bond length of CO is 1.128 Å. Find its Bond length is $[Fe(CO)_5]$)

1. 1.096 Å
2. 2.64 Å
3. 1.128 Å
4. 1.15 Å

QUESTION

Order of bond length of CO in $Cr(CO)_6$, $[V(CO)_6]^-$, $[Mn(CO)_6]^+$ will be ?

A B C

$C < A < B$

Ex. $[Ni(CO)_4] > [Ni(PF_3)(CO)_3]$

more donation

less donation

If PF_3 is better π acceptor than CO then Find CO B.L order.

Ex. $[Cr(CO)_6] < [Fe(CO)_5] < [Ni(CO)_4]$ ($C-O$ B.L order)

Ex. $[Ni(CO)_3 PF_3] < [Ni(CO)_3 PMe_3]$

More donation

less donation

less donation

More donation

(-8) ↑se e⁻ accepting Power From CMI ↓se

P

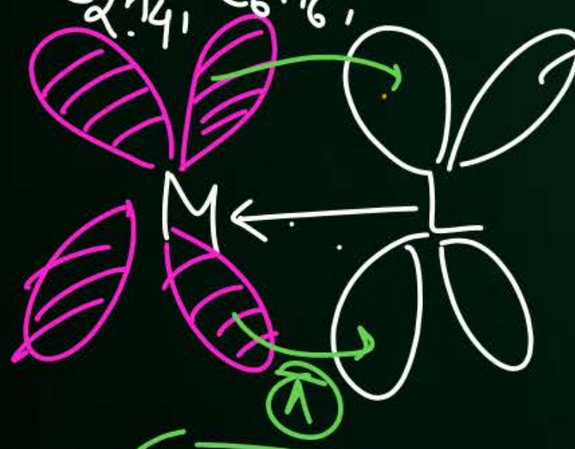
+I Me Me Me

π-acceptor ligands

Accept into π ABMO.

CO, CN^-, NO^+ ... etc.

C_2H_4, C_6H_6;



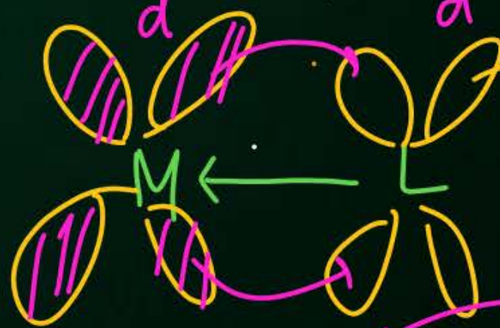
→ P type ABMO ($\pi^*_{2P_x}$ / $\pi^*_{2P_y}$) if INA = 2

dπ - pπ

accept into Vacant "d" orbitals.

PR_3, PF_3, AsR_3 ... etc.

Vacant "d" orbitals are present to accept e^- from CMI



dπ - dπ Bonding

IUPAC Nomenclature of coordination compounds

1. Name the cation first.

2. For cationic [ ]$^{+}$ or neutral [ ]° complexes.

Number of ligands (bi, tri, tetra Penta, hexa...etc) + Name of ligands (Alphabatical Order) + Name of CMI + (O.N of CMI in Roman)

3. For anionic complex [ ]$^{-}$ add 'ate' suffix with metal.

All Rule remains Same but add Suffix "ate" in the name of CMI.

In case of Anionic complex :

Fe - Ferrate
Sn - Stannate
Pb - Plumbate
Ag - Argentate
Au - Aurate
Cu - Cuperate
Co - Cobaltate
Zn - Zincate
Ni - Nickelate
Cr - Cromate
Pt - Platinate
Pd - Palladate

Al → Aluminate.

④ Ligands which already have prefixes like bi, tri, tetra.. etc in their name.

then Bis, tris, tetrakis words are used to indicate their numbers.

Ex en ⇒ ethylene (di) amine.

PPh_3 (Tri) phenyl phosphine

$( )_2$ → Bis

$( )_3$ → tris

$( )_4$ → tetrakis

① $K_4[Fe(CN)_6]$ — $+6$ and -4; O.N. $= +2$

Potassium hexacyanidoferrate(II)

② $[Co(NH_3)_5Cl]Cl_2$ — $+1$ and $+2 \rightarrow +3$ (O.N)

pentaamminechloridocobalt(III) Chloride

③ $[Co(en)_3]Cl_3$ — 0 and $+3 \rightarrow +3$

tris-(ethylenediamine)cobalt (III) Chloride

or

1,2 diamine ethane.

Homework

Write the IUPAC names of the following coordination compounds :

(i) $[Cr(NH_3)_3\ (H_2O)_3]Cl_3$

(ii) $[Co(\overbrace{H_2NCH_2CH_2NH_2}^{en})_3]_2(SO_4)_3$

(iii) $[Ni(CO)_4]$

(iv) $[CoCl_2(en)_2]^+$

(v) $[Co(NH_3)_4(H_2O)Cl]Cl_2$

Home work

(vi) $[Pt(NH_3)_2Cl(NO_2)]$

(vii) $[Co(NH_3)_5(CO_3)]Cl$ → (Carbonato)

(viii) $K_3[Al(C_2O_4)_3]$

(ix) $K_3[Fe(CN)_6]$

(x) $K_2[PdCl_4]$

(xi) $[Co(NH_3)_5Cl]Cl_2$

(xii) $[NiCl_2(PPh_3)_2]$

QUESTION

The name of complex ion, $[Fe(CN)_6]^{3-}$ is

[Re-AIPMT 2016]

1. Tricyanoferrate (III) ion
2. Hexacyanidoferrate (III) ion
3. Hexacyanoiron (III) ion
4. Hexacyanitoferrate (III) ion

THANK YOU

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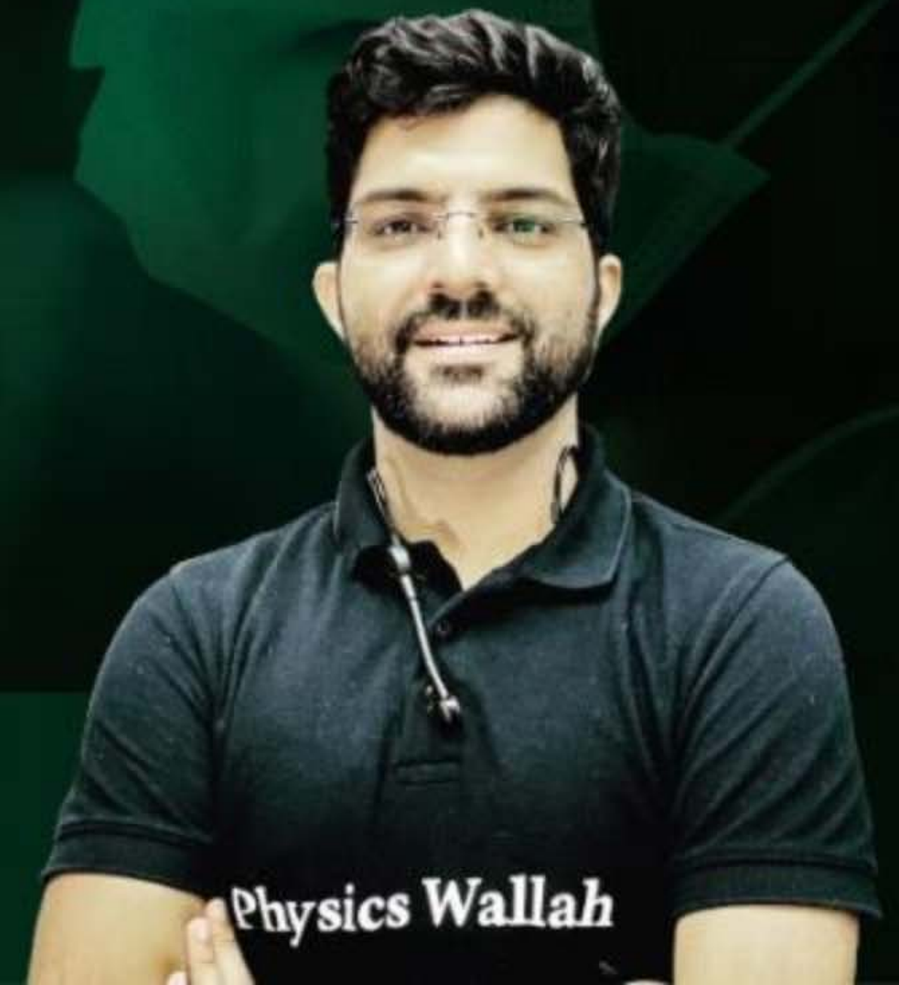
FOR NEET 2025

Lecture - 5 | Inorganic Chemistry

Coordination Compounds



By - Mohit Dadheech (MD Sir)

Topics *to be covered*

1. IUPAC (Remaining part)
2. Werner's Theory.

(i) $[Ag(NH_3)_2]$ $[Ag(CN)_2]$

O.N = +1 ← 0 ... +1 ; −2 ... −1 → Ag (+1)

diamminesilver(I) dicyanidoargentate(I)

(ii) $[Pt(en)_3]$ $[PtCl_4]$ $[\ ]^{+4}$ $[\ ]^{2-}_2$

Pt^{+4} ← 0 ... +4 ; −4 ... 2− → Pt^{+2}

tris-(ethylendiamine) platinum(IV) tetrachlorido platinate(II)

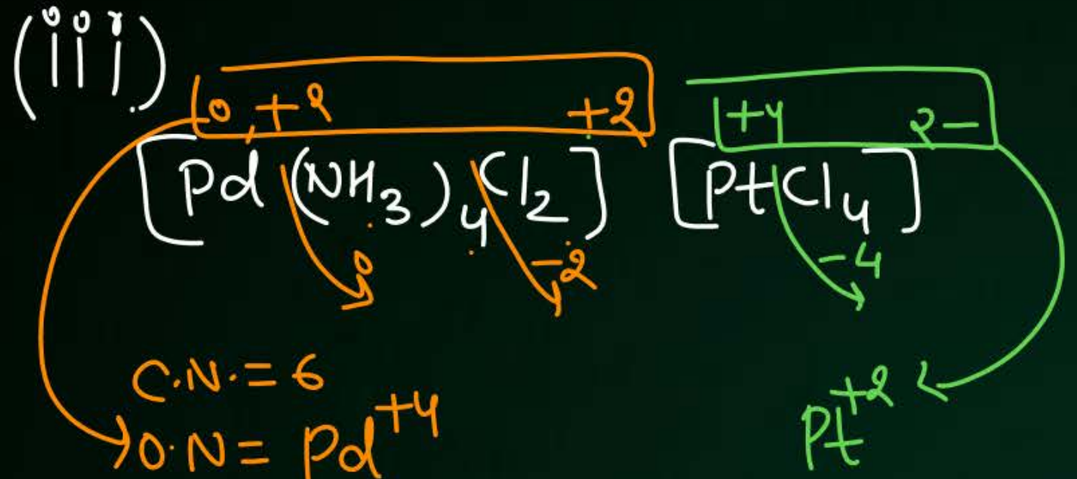
O.N of CMI assume on the basis of C.N.

	C.N.	O.N
Pd / Pt	6	+4
	4	+2

Ag → Always +1

Zn → Always (+2)

(iii)



tetraamminedichloridopalladium(IV) tetrachloridoplatinate(II)

(iv) $[Pt(en)_2Cl_2][ZnCl_4]$ dichloridobis-(ethylenediamine) platinum(IV) tetrachloridozincate (II)

Homework

Write the IUPAC names of the following coordination compounds :

(i) $[Cr(NH_3)_3(H_2O)_3]Cl_3$ triamminetriaquachromium(III) chloride

(ii) $[Co(\overbrace{H_2NCH_2CH_2NH_2}^{en})_3]_2(SO_4)_3$ tris-(ethylenediamine)cobalt(III) Sulphate

(iii) $[Ni(CO)_4]$ tetracarbonylnickel(0)

(iv) $[Co^{+2}Cl_2^{-2}(en)_2]^+$ dichloridobis-(ethylenediamine)cobalt(III) ion

(v) $[Co(NH_3)_4(H_2O)Cl]Cl_2$ tetraamminaquachloridocobalt(III) chloride.

(vi) $[Pt(NH_3)_2Cl(NO_2)]$ diammine chlorido nitrito-N platinum(II)

(vii) $[Co(NH_3)_5(CO_3)]Cl$ pentaammine carbonato cobalt (III) chloride

(viii) $K_3[Al(C_2O_4)_3]$ potassium trioxalatoaluminate (III)

(ix) $K_3[Fe(CN)_6]$

(x) $K_2[PdCl_4]$ Potassium tetrachlorido palladate(II)

(xi) $[Co(NH_3)_5Cl]Cl_2$

(xii) $[NiCl_2(PPh_3)_2]$ dichlorido bis-(triphenylphosphine) nickel (II)

QUESTION

The coordination number and the oxidation state of the element 'E' in the complex $[E(en)_2(C_2O_4)]NO_2$ (where (en) is ethylene diamine) are, respectively

[JEE Main - 2008]

1. 6 and 2
2. 4 and 2
3. 4 and 3
4. 6 and 3

QUESTION

Ethylene diaminetetraacetate (EDTA) ion is :

[NEET - 2021]

1. Unidentate ligand
2. Bidentate ligand with two "N" donor atoms
3. Tridentate ligand with three "N" donor atoms
4. Hexadentate ligand with four "O" and two "N" donor atoms

QUESTION

The calculated spin only magnetic moment of Cr^{2+} ion is

[NEET - 2020]

1. 4.90 BM
2. 5.92 BM
3. 2.84 BM
4. 3.87 BM

d^4

4.....

$\mu = \sqrt{n(n+2)}$ $\sqrt{24}$ 4....

QUESTION

Which of the following complexes are homoleptic ?

[NCERT EXEMPLAR]

(a) $[Co(NH_3)_6]^{3+}$
(b) $[Co(NH_3)_4Cl_2]^{+}$
(c) $[Ni(CN)_4]^{2-}$
(d) $[Ni(NH_3)_4Cl_2]$

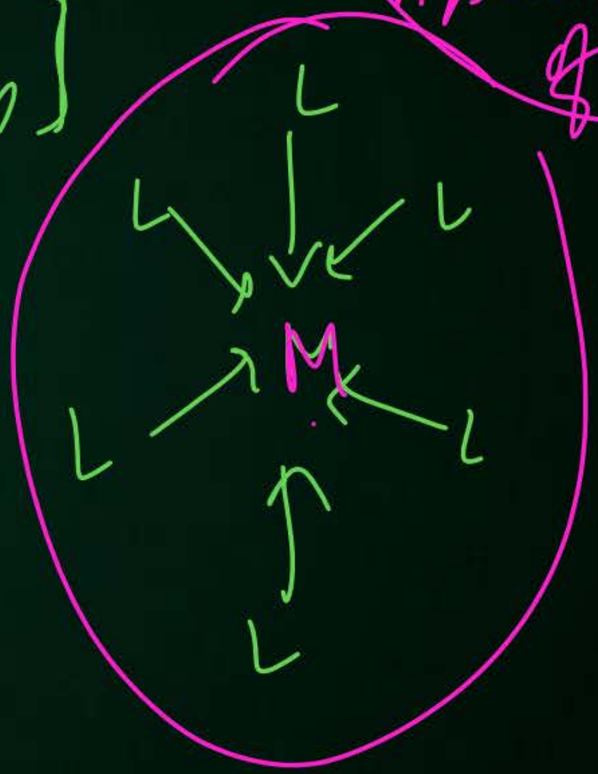
1. a, c, d
2. b, c, d
3. b, c
4. a, c

Theories of coordination compound :

* Werner's Theory
* Valence Bond Theory
* Crystal Field Theory

$X[ML_n]$

Shape
Hybridisation
of CMI



$CrCl_3 \cdot 5NH_3$

Cr^{3+} — C.N — Charge satisfy

1° valency

C.N

2° valency — no. of σ Bonds around Metal

$[Cr(NH_3)_5Cl]Cl_2$

H_2O

$[\quad]^{2+}$

$2Cl^-$

total 3 ions

① Conductance measurement

② by the Use of Reagent

Ex Excess $AgNO_3$

$AgCl\downarrow$

$AgBr\downarrow$

Werner's Theory :

Werner's studies no. of complexes and found that metal ion in a complex has two types of valency (i) Primary valency (ii) Secondary valency

(1°) (2°)

Primary valency	Secondary valency
* 1° valency is equal to O.N. of CMI	2° valency is equal to C.N. of CMI
* 1° Valency satisfied by anions	→ satisfied by neutral molecules as well as anions.
* Ionizable in nature	→ Non ionizable.
* Non-directional.	→ directional.
* Represented by (- - -) dotted lines	→ Represented by (——) solid lines.
* geometry of Complex can not be predicted by 1° valency	→ geometry can be predicted.

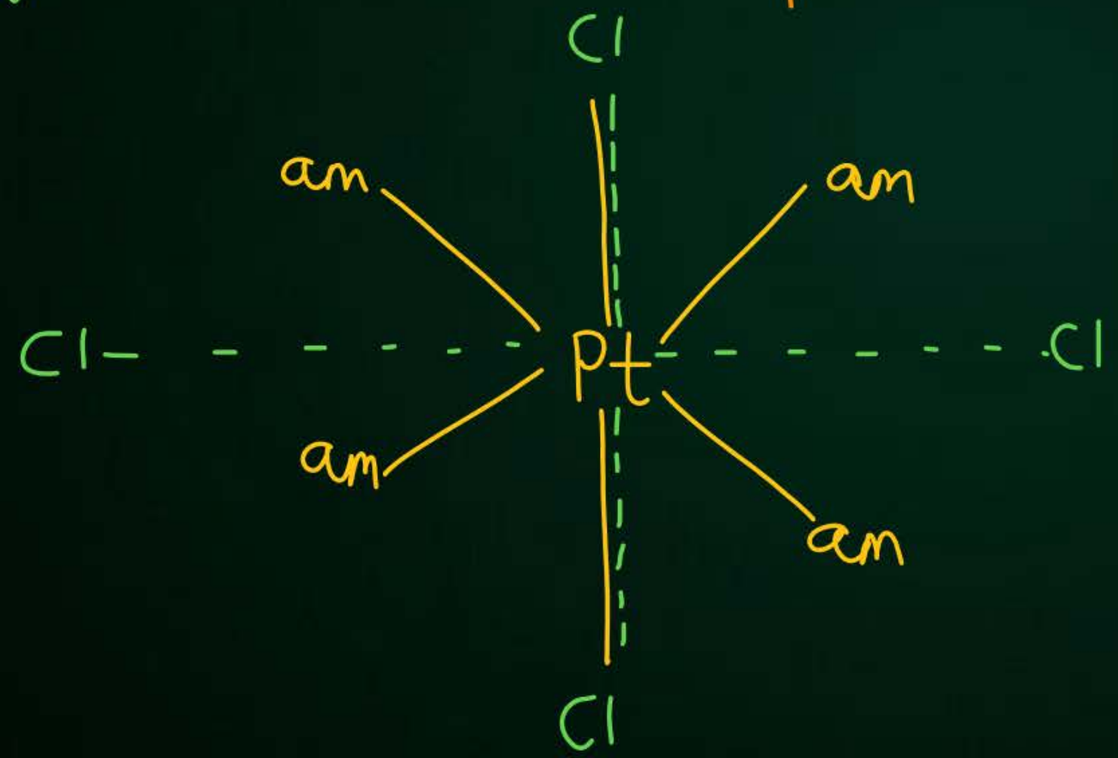
$\overset{+4}{PtCl_4} \cdot 4NH_3$

given

no. of ions produced = 3

Modern formula

no. of AgCl moles → 2



$[Pt(NH_3)_4Cl_2]Cl_2$

O.N of Pt ⇒ +4

1° valency = 4

C.N. of Pt ⇒ 6

2° valency = 6

4 → 2 ionizable

4 → 2 non ionisable (dual)

% of ionizable Cl^- ions → 50%

% of non ionizable Cl^- ion → 50%

Ex $[Pt(NH_3)_3Cl_3]Cl$

type of electrolyte ratio

1° Valency → 4 (O.N +4)

2° Valency → 6 (C.N = 6)

no. of ions produced — 2

no. of AgCl mole on Reaction with excess $AgNO_3$ ⇒ 1 AgCl ↓

% of non ionisable Cl^- ions → 75%

% of ionisable Cl^- ions → 25%

QUESTION

When 0.1 mole $CoCl_3(NH_3)_5$ is treated with excess of $AgNO_3$, 0.2 mole of AgCl are obtained. The conductivity of solution will correspond to

[NCERT EXEMPLAR]

1. 1 : 3 electrolyte
2. 1 : 2 electrolyte
3. 1 : 1 electrolyte
4. 3 : 1 electrolyte

$[Co(NH_3)_5Cl]Cl_2$

$[\ ]^{2+} : 2Cl^-$

QUESTION

When 1 mol $CrCl_3.6H_2O$ is treated with excess of $AgNO_3$, 3 mol of AgCl are obtained. The formula of the complex is

[NCERT EXEMPLAR]

1. $[CrCl_3(H_2O)_3].3H_2O$
2. $[CrCl_2(H_2O)_4]Cl.2H_2O$
3. $[CrCl(H_2O)_5]Cl_2.H_2O$
4. $[Cr(H_2O)_6]Cl_3$ ✓

$[Cr(H_2O)_6]Cl_3$

QUESTION

C.N. = 6

Cobalt (III) chloride forms several octahedral complexes with ammonia. Which of the following will not give test of chloride ions with silver nitrate at 25°C?

[AIPMT - 2015]

1. $CoCl_3 \cdot 4NH_3$ $[Co(NH_3)_4Cl_2]Cl$ $[\ ]Cl$ ✗
2. $CoCl_3 \cdot 5NH_3$ $[Co(NH_3)_5Cl]Cl_2$
3. $CoCl_3 \cdot 6NH_3$ $[Co(NH_3)_6]Cl_3$
4. $CoCl_3 \cdot 3NH_3$ $[Co(NH_3)_3Cl_3]^0$ → ~~AgCl ppt~~ ; ~~electrolyte~~ : (no. of ions = 0)

QUESTION

The correct order of the stoichiometries of AgCl formed when $AgNO_3$ in excess is treated with the complexes: $CoCl_3.6NH_3$, $CoCl_3.5NH_3$, $CoCl_3.4NH_3$ respectively is : [NEET 2017]

$[Co(am)_6]Cl_3$ $[Co(am)_5Cl]Cl_2$ $[Co(am)_4Cl_2]Cl$

3 AgCl 2 AgCl 1 AgCl

1. 1AgCl, 3AgCl, 2AgCl
2. 3AgCl, 1AgCl, 2AgCl
3. 3AgCl, 2AgCl, 1AgCl
4. 2AgCl, 3AgCl, 1AgCl

THANK YOU

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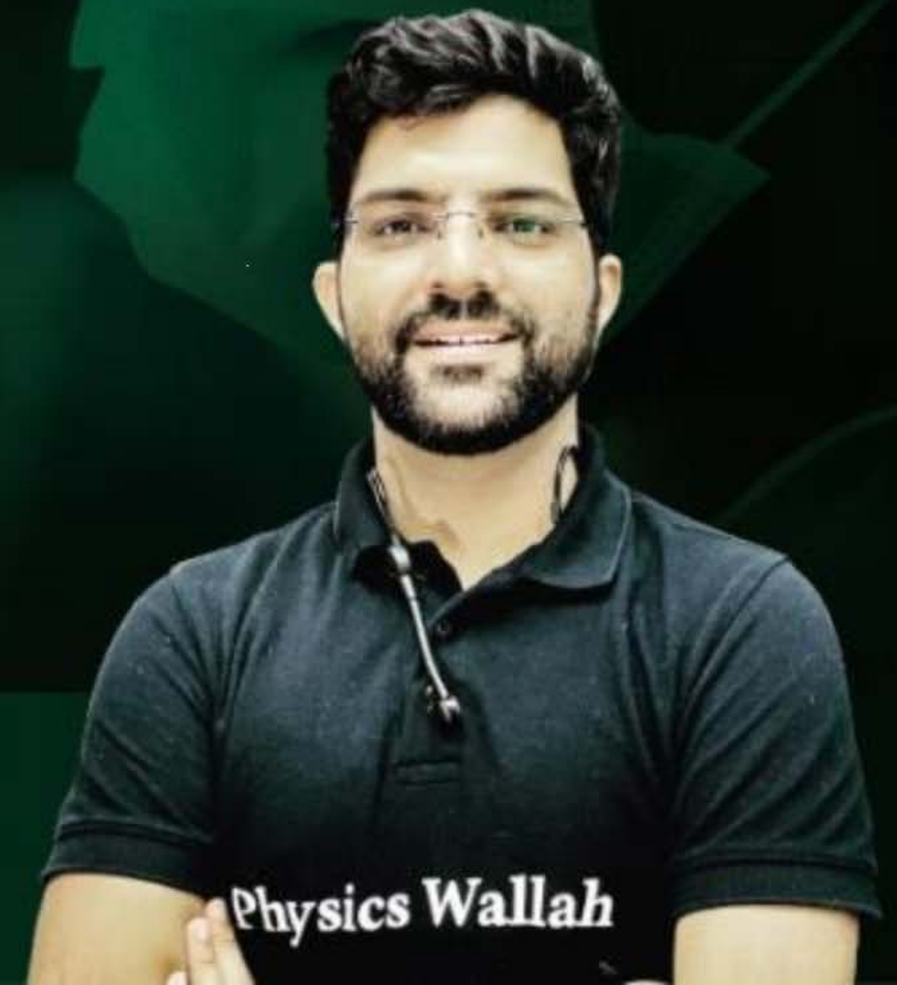
FOR NEET 2025

Lecture - 06 | Inorganic Chemistry

Coordination Compounds



By - Mohit Dadheech (MD Sir)

Topics *to be covered*

1. VBT
2.

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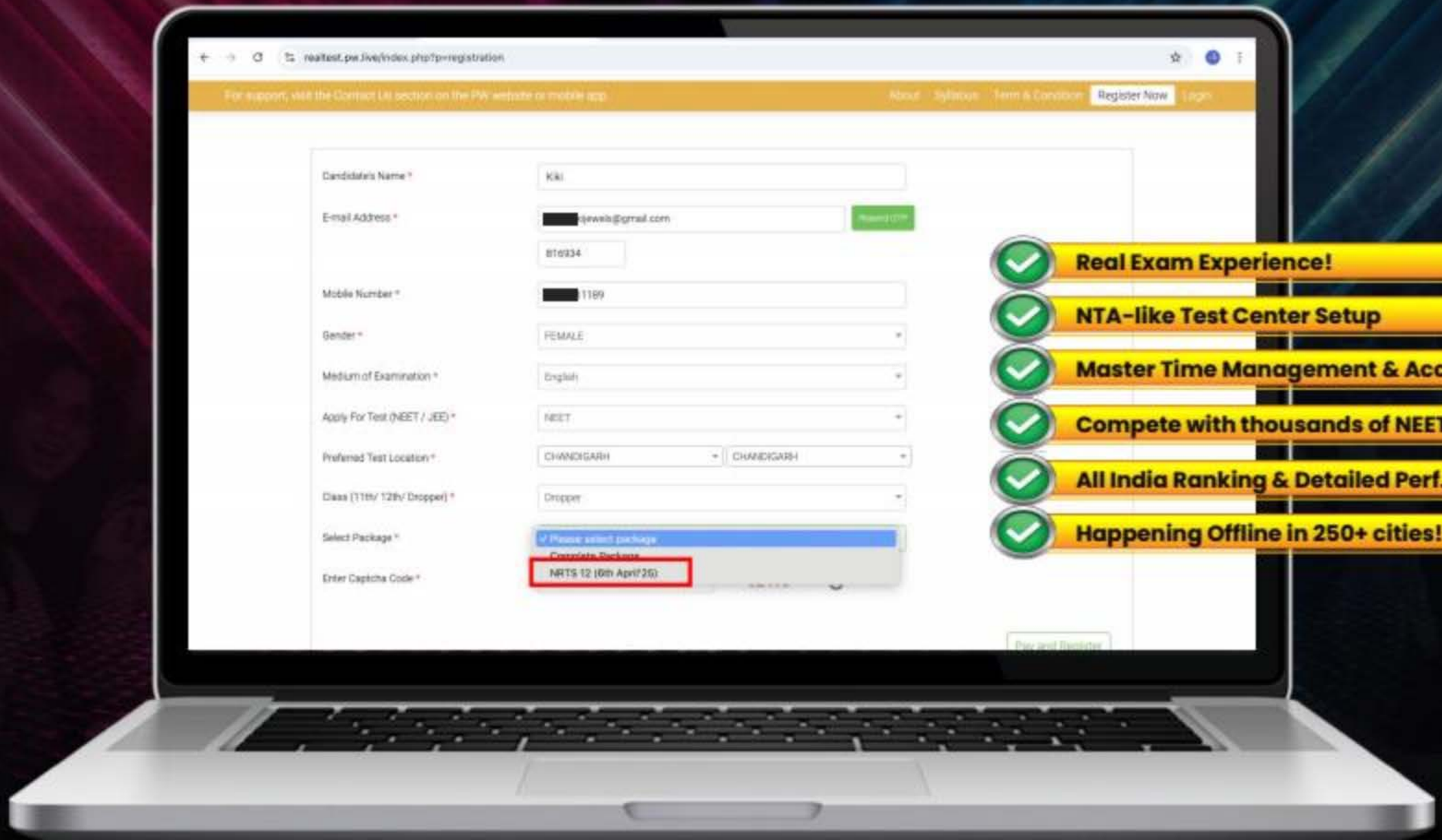

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Q Primary Valency (1°) of Compounds $\overset{+4}{Pt}Cl_4 \cdot 5NH_3$; $\overset{+4}{Pt}Cl_4 \cdot 4NH_3$ and $\overset{+4}{Pt}Cl_4 \cdot 3NH_3$ are respectively.

(1) 5, 4, 3

(2) 3, 4, 5

(3) 4, 4, 4

(4) 5, 5, 3

On the basis of the Following observations made with aq. sol. assign 2° valency to metals in Following.

	given no. of AgCl moles
$PdCl_2 \cdot 4NH_3$	2
$NiCl_2 \cdot 6H_2O$	2
$PtCl_4 \cdot 2HCl$	0
$CoCl_3 \cdot 4NH_3$	1
$PtCl_2 \cdot 2NH_3$	0

Formula	2° Valency	no. of ions
$[Pd(NH_3)_4]Cl_2$	4	3
$[Ni(H_2O)_6]Cl_2$	6	3
$H_2[PtCl_6]$	6	3
$[Co(NH_3)_4Cl_2]Cl$	6	2
$[Pt(NH_3)_2Cl_2]$	4	0

There is a Coordinate Bonds b/w M & L

Requirements

- Vacant orbitals at CMI
  - (n-1)d ns np nd
- Vacant orbitals → Hybridise
  - definite geometry.
  - same Energy
  - definite orientation
- Overlapping b/w (vacant) N.O of CMT & filled orbitals of Ligands

Valence Bond Theory :

Filled → Bharq Hua

Geometry, hybridisation, etc in a complex can be predicted from coordination no. of metal ion.

Some Imp. Points :- According to VBT -

(i) CMI makes available Vacant Orbitals to ligands.

(ii) Number of orbitals provided by CMI are equal to Coordination no.

(iii) These orbitals of CMI hybridize to provide set of equivalent & definite geometry orbitals.

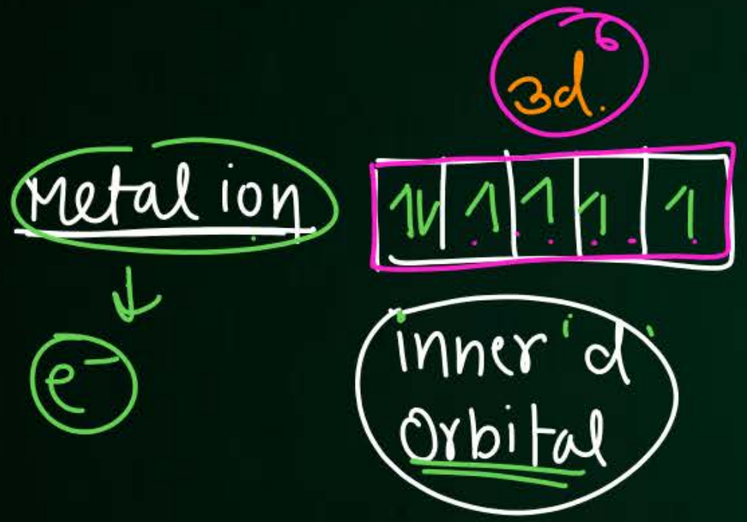
(iv) Vacant hybrid orbitals of CMI overlap with Filled Orbitals of ligands to Form σ Coordinate Bonds.

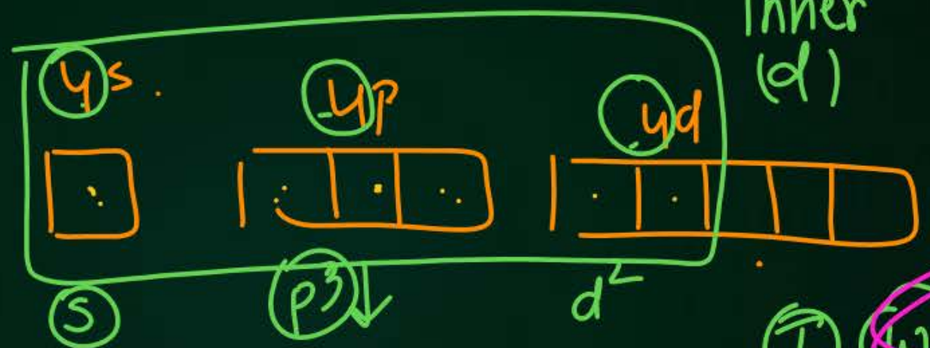
For Ex

Fe^{2+} . $3d^6$ $4s^0$ $4p^0$ $4d^0$

$3d^6$ → $(n-1)d$ inner (d)

$4d^0$ → nd outer (d)





sp^3d^2

Same P.Q.N

(I) Weak ligands

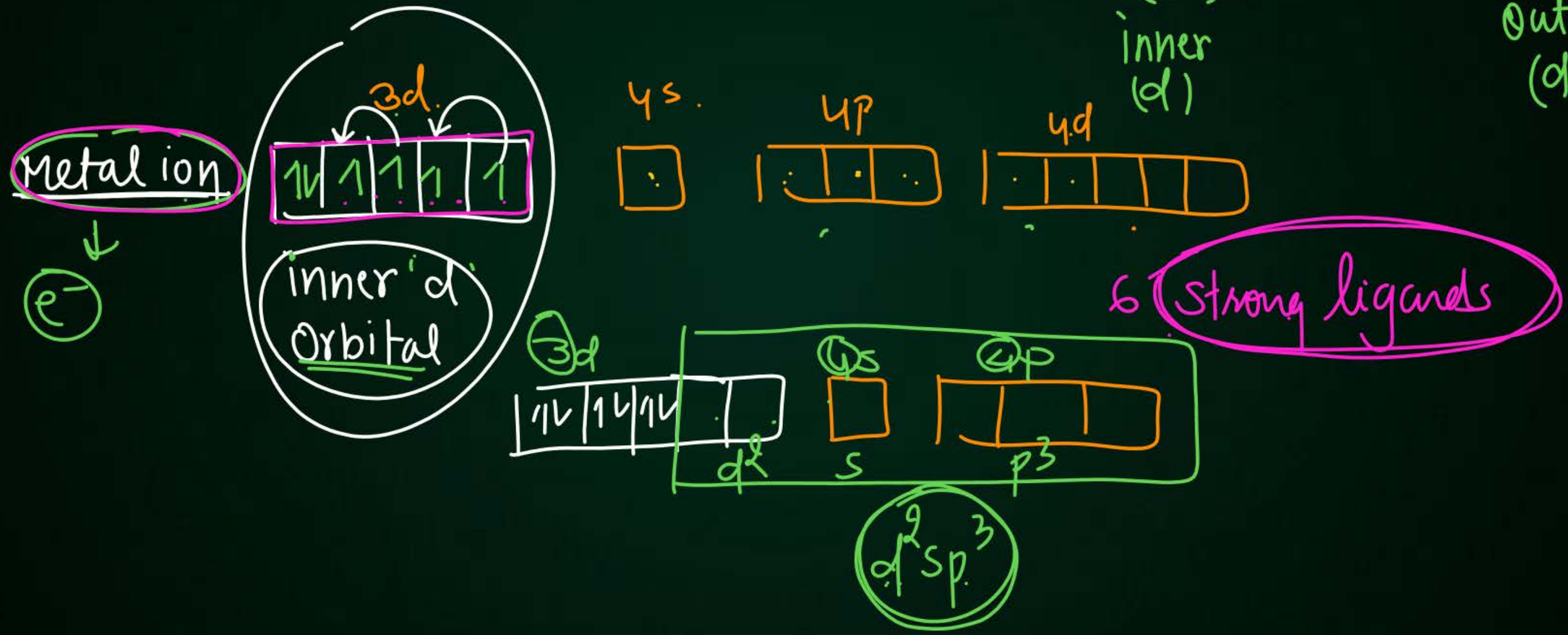
no. of (6)

For Ex

Fe^{2+} . $3d^6$ $4s^0$ $4p^0$ $4d^0$

$3d^6$ → $(n-1)d$ inner (d)

$4d^0$ → nd outer (d)



NOTE

* non bonding e^- of CMI occupy inner orbitals

(i) → These e^- are arranged according to Hund's Rule.
When the Complex are Formed by weak ligands.
like., H_2O, F^-, Cl^- _ _ etc.

(ii) But when ligands are strong like NH_3, CN^-, CO .. etc
these e^- are rearranged against Hund's Rule vacating
Certain "d" orbitals to participate in Hybridisation

#MDJ

Hybridisation

When Same no. of P.Q.N. (n) Involved.

Orbitals of Ultimate (n^{th}) shell participates into Hybridisation

For. Ex

$4s + 4p + 4d$

$ns + np + nd$ *

Outer d are Used → Outer orbital Complexes

Mixing

Type of Hybridisation → sp^3d, sp^3d^2

When diff P.Q.N. (n) are involved.

Orbitals of Penultimate ($(n-1)^{th}$) shell are also participate along with Ultimate (n^{th}) shell's Orbitals.

For. Ex

Inner d's are Used → Inner orbital Complexes

$(n-1)d$ * | ns | np → Mixing

$3d$ | $4s$ | $4p$

Type of Hybridisation

dsp^2, dsp^3, d^2sp^3

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p\ 4d$

$(n-2)$ $(n-1)$ $n=4$

Pre penultimate $(4-1)=3$

or

Anti penultimate $(n-1)^{th}$ shell

Penultimate

n^{th} shell

Ultimate shell

ligand strength (donation strength)

donor atoms

C > N > O > X

gen. strong ligands

weak donors

$F^- > Cl^- > Br^- > I^-$

Strong ligands		Weak ligands.
(i) They can pair "d" e^- if required	→	Can not pair "d" e^- ✓
(ii) "Gen." Form diamagnetic Complexes.	→	Paramagnetic Complexes. ✓
(iii) Gen. Form Low spin Complexes		High spin Complexes ✓
(iv) Gen. Form Innerorbital Complexes		Outer orbital Complexes.

No. of Vacant orbitals Participates into Hybridisation	Coordination no. / no. of σ Coordinate Bonds	Type of Hybridisation	Type of "d" used
2.	2.	sp. linear	—
3.	3	sp^2 T. planar	—
4.	4.	sp^3 Tetrahedral.	—
4.	4	dsp^2 Sq. planar.	dx^2-y^2
5.	5	dsp^3 / sp^3d Trigonal Bipyramidal.	dz^2
6.	6	d^2sp^3 / sp^3d^2 Octahedral / sq. Bipyramidal	dz^2, dx^2-y^2

$K_4[Fe(CN)_6]$ Fe^{2+} $3d^6 4s^0 4p^0 4d^0$

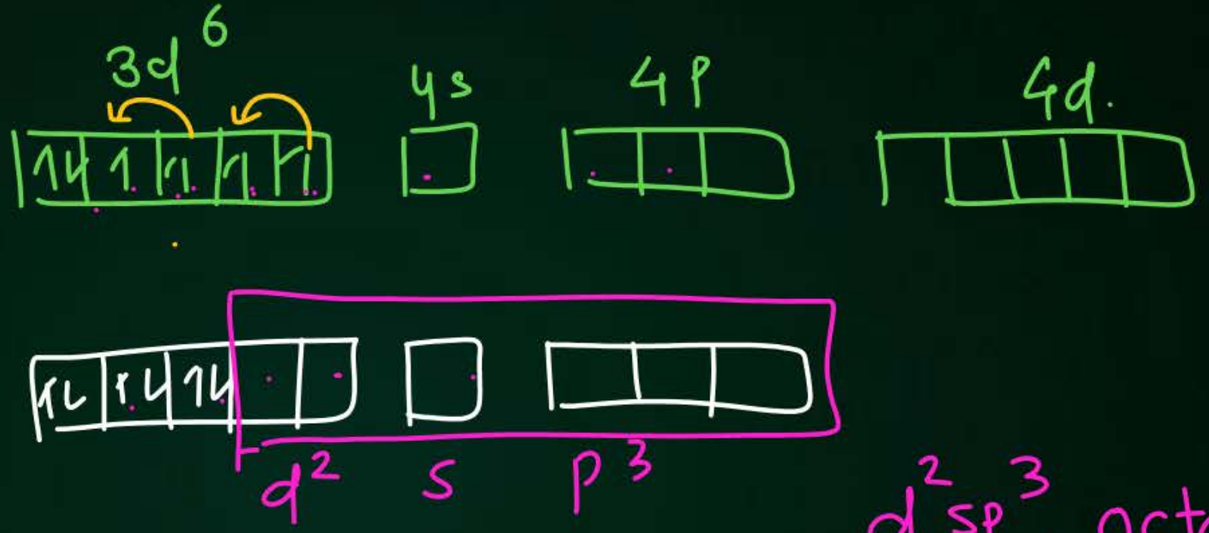
CN^-

C-donor

Strong ligand.

Pairing ↓

$6CN^-$ C.N. = 6

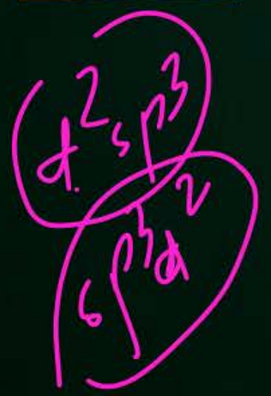


d^2sp^3, octahedral.

Low spin Complex.

n=0, diamagnetic.

Inner d complex.

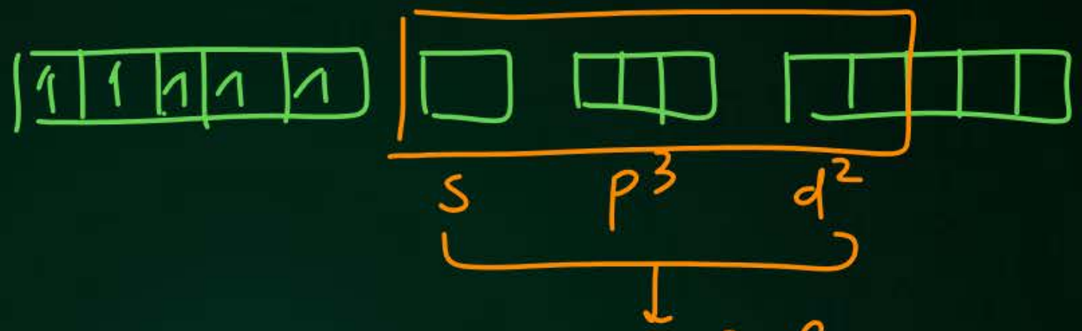


$K_3[FeF_6]$ Fe^{3+} $3d^5\ 4s^0\ 4p^0\ 4d^0$

C.N. = 6
octahedral.

F^- → weak.

Pairing

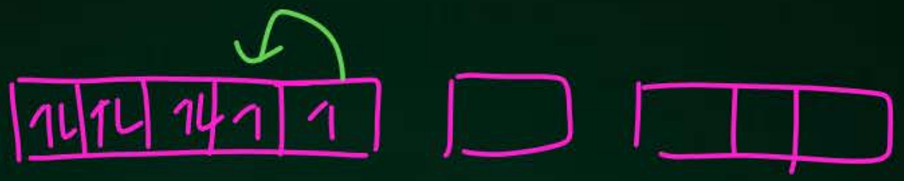


sp^3d^2
Octahedral.
High Spin.
n=5, Paramagnetic.
outer orbital Complex.

$[Ni(CN)_4]^{2-}$ Ni^{+2} $3d^8 4s^0 4p^0 4d^0$

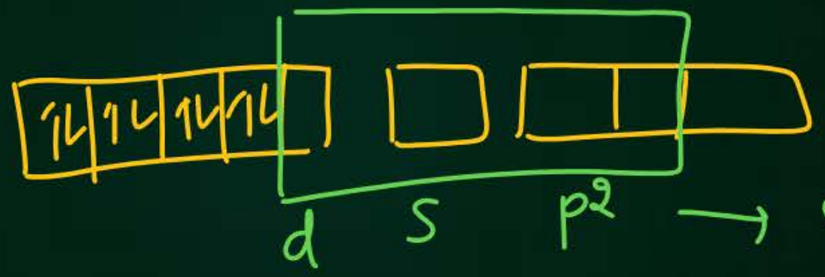
CN. = 4

dsp^2 sp^3



CN^- → strong ligand

Pairing ✓



→ dsp^2

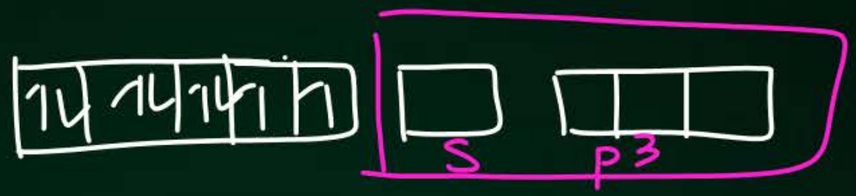
Sq. planar.

Low Spin

n = 0 , diamagnetic.

$[NiCl_4]^{2-}$ $Ni^{2+} \rightarrow 3d^8 4s^0 4p^0 4d^0$.

Cl^- → weak ligand.



Pairing

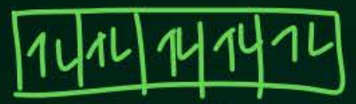
sp^3; tetrq

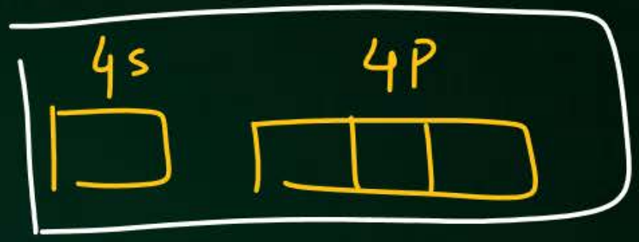
n=2, Parq

$[Ni(CO)_4]$

Ni^0 $3d^8$ $4s^2$ ← e^-

$3d^{10}$





sp^3, tetrahedral.

$\eta = 0$ dia magnetic

$[Cr(NH_3)_6]^{3+}$ Cr^{3+} d^3

MDT

$d^1/d^2/d^3$ → 6 Ligands → S-L/W-L

M=1 ... 2 ... 3 ...

Always inner

d^2sp^3

Paramagnetic

Ex $[Ti(H_2O)_6]^{3+}$ $Ti^{+3} \rightarrow d^1$

$n=2$ d^8 / $n=1$ d^9 / d^{10} → 6 ligand →

Always Outer Complex

sp^3d^2

Para

dia

$n=0$

Ex $[Ni(NH_3)_6]^{2+}$ Ni^{2+} $3d^8$

Magnetic Moment $(\mu) = \sqrt{n(n+2}$

#MDJ Jitna Unpaired e^- Utna Point Something.

Home work

Find geometry, hybridisation, types of complex (inner / outer) and no. of unpaired electron in following complexes

1. $K_4[Fe(CN)_6]$
2. $K_3[Fe(CN)_6]$
3. $K_3[FeF_6]$
4. $[Fe(CO)_5]$
5. $[CoF_6]^{3-}$
6. $[Co(H_2O)_6]Cl_3$
7. $K_3[Co(OX)_3]$
8. $[MnCl_4]^{2-}$
9. $[Fe(H_2O)_5NO]SO_4$
10. $[Mn(NH_3)_6]SO_4$

11. $K_3[Mn(CN)_6]$
12. $[NiCl_4]^{2-}$
13. $[Ni(CN)_4]^{2-}$
14. $[Ni(CO)_4]$
15. $[Ni(en)_3]Cl_2$
16. $[Ni(en)_2]Cl_2$
17. $K_3[CrF_6]$
18. $[Cr(NH_3)_3Cl_3$
19. $K_3[Cu(CN)_4]$
20. $[Cu(NH_3)_4]SO_4$
21. $K_2[Cd(CN)_4]$
22. $K_2[HgI_4]$
23. $[Pt(NH_3)_2Cl_2]$
24. $K_2(PtCl_4)$
25. $K_2(PtCl_6)$
26. $[PdCl_4]^{2-}$

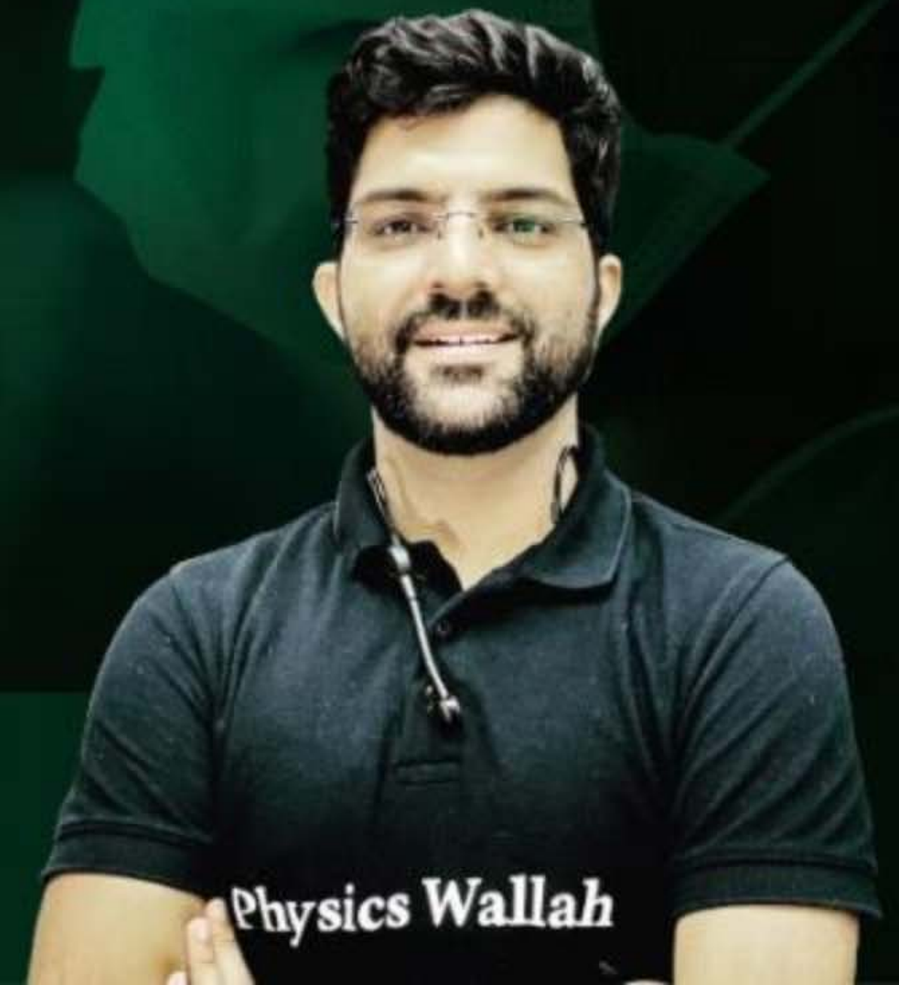
THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture - 07 | Inorganic Chemistry

Coordination Compounds



By - Mohit Dadheech (MD Sir)

Topics *to be covered*

1. Crystal Field Theory.
2.

Transfer Rule : Special cases

If required 1 electron can be excited to high energy orbital, but in presence of strong ligand only.

(Ex. 1) $[Co(CN)_6]^{-4}$

(Reducing agent)

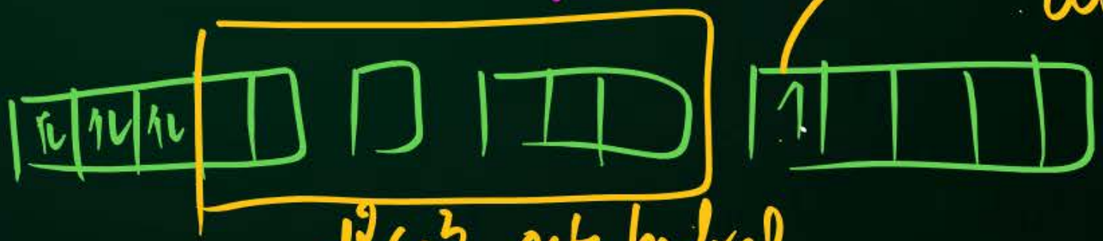
$[Co(CN)_6]^{4-}$ $\xrightarrow{-e^-}$ $[Co(CN)_6]^{3-}$

$0.5 = Co^{2+}$ $\quad$ $0.5 = Co^{3+}$

$Co^{2+} \rightarrow 3d^7\ 4s^0\ 4p^0\ 4d^0$

CN^- (S.L)

$1e^-$ Transfer



d^2sp^3, octahedral

$n=1$ (Para)

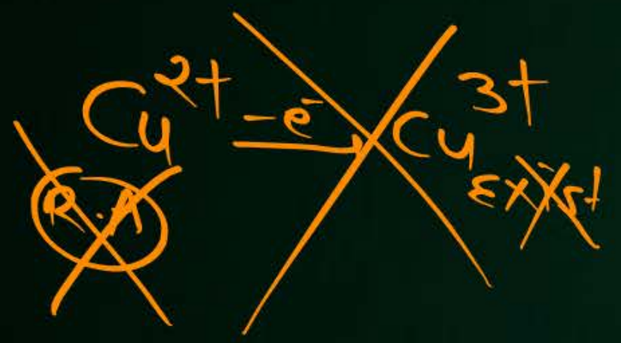
This e^- is present at higher energy level so it can be easily donated

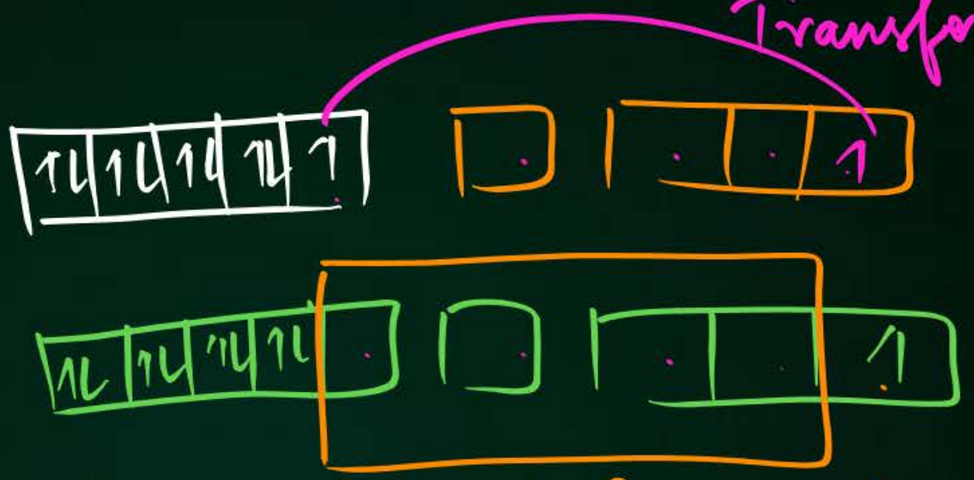
$\therefore [Co(CN)_6]^{4-}$ act as R.A

Ex. 2

$[Cu(NH_3)_4]SO_4$. Cu^{2+} $3d^9\ 4s^0\ 4p^0$.

C.N. = 4





dsp^2, sq. planar

n=1, para.

Reducing in nature

Strength Rule :

#MDJ

(i) [4d / 5d series Metals] → All ligands → Strong ligands.

More Z_{eff} ← More strong attraction towards ligands.

Ex $[PtCl_4]^{2-}$ Cl^- work as S.L

(ii) M^{+4} → All ligands → S.L

(iii) Co^{3+} → 'O' donor ligands → ~~W.L~~ S.L ✓

(iv) Cr^{2+}, Mn^{2+}, Fe^{2+}, Co^{2+} → NH_3 → ~~S.L~~ W.L ✓

Find geometry, hybridisation, types of complex (inner / outer) and no. of unpaired electron in following complexes

1. $K_4[Fe(CN)_6]$ — d^2sp^3, octa, inner, n = 0, diamagnetic
2. $K_3[Fe(CN)_6]$ — d^2sp^3, octa, inner, n = 1, para
3. $K_3[FeF_6]$ — sp^3d^2, octa, outer, n = 5, para
4. $[Fe(CO)_5]$ — dsp^3, T.B.P, inner, n = 0, dia
5. $[CoF_6]^{3-}$ — sp^3d^2, octa, outer, n = 4, para
6. $[Co(H_2O)_6]Cl_3$ — d^2sp^3, octa, inner, n = 0, dia
7. $K_3[Co(OX)_3]$ — d^2sp^3, octa, inner, n = 0, dia
8. $[MnCl_4]^{2-}$ — sp^3, tetra, n = 5, para
9. $[Fe(H_2O)_5NO]SO_4$ — sp^3d^2, octa, outer, n = 3, para
10. $[Mn(NH_3)_6]SO_4$ — sp^3d^2, octa, outer, n = 5, para

2e⁻ tranfer

Fe^0 $3d^6 4s^2$ → $3d^8 4s^0$

Co^{3+} with "O" donor → S.L

Mn^{2+} with NH_3 → W.L ~~S.L~~

11. $K_3[Mn(CN)_6]$ — d^2sp^3, octa, inner, n = 2, para

12. $[NiCl_4]^{2-}$ — sp^3, tetra, n = 2, para

13. $[Ni(CN)_4]^{2-}$ — dsp^2, Sq. Planar, n = 0, dia

14. $[Ni(CO)_4]$ — sp^3, tetra, n = 0, dia

15. $[Ni(en)_3]Cl_2$ — sp^3d^2, octa, outer, n = 2, para

16. $[Ni(en)_2]Cl_2$ — dsp^2, Sq. Planar, n = 0, dia

17. $K_3[CrF_6]$ — d^2sp^3, octa, inner, n = 3, para

18. $[Cr(NH_3)_3Cl_3]$ — d^2sp^3, octa, inner, n = 3, para

19. $K_3[Cu(CN)_4]$ — sp^3, tetra, n = 0, dia

20. $[Cu(NH_3)_4]SO_4$ — dsp^2, Sq. Planar, n = 1, para] transfer Rule Vala Case

21. $K_2[Cd(CN)_4]$ — sp^3, tetra, n = 0, dia

22. $K_2[HgI_4]$ — sp^3, tetra, n = 0, dia

23. $[Pt(NH_3)_2Cl_2]$ — dsp^2, Sq. Planar, n = 0, dia

24. $K_2(PtCl_4)$ — dsp^2, Sq. Planar, n = 0, dia

25. $K_2(PtCl_6)$ — d^2sp^3, octa, inner, n = 0, dia

26. $[PdCl_4]^{2-}$ — dsp^2, Sq. Planar, n = 0, dia

d^{10} → C.N = 4 → sp^3 Always

C.N = 6 → sp^3d^2 Always

With 4d/5d Metal
All ligands S.L

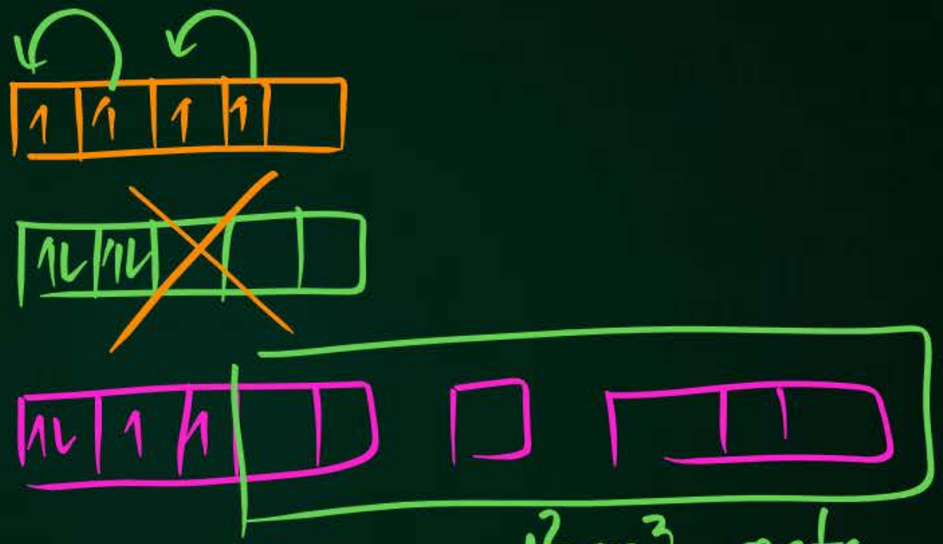
$K_3[Mn(CN)_6]$ Mn^{3+} $3d^4$ $4s^0$ $4p^0$ $4d^0$

CN^- S.L

Pairing

Octahedral

Pairing utni hi
kami Hai Jitni
Required Ho !!



d^2sp^3, octa

n=2, Para M = 2 .....

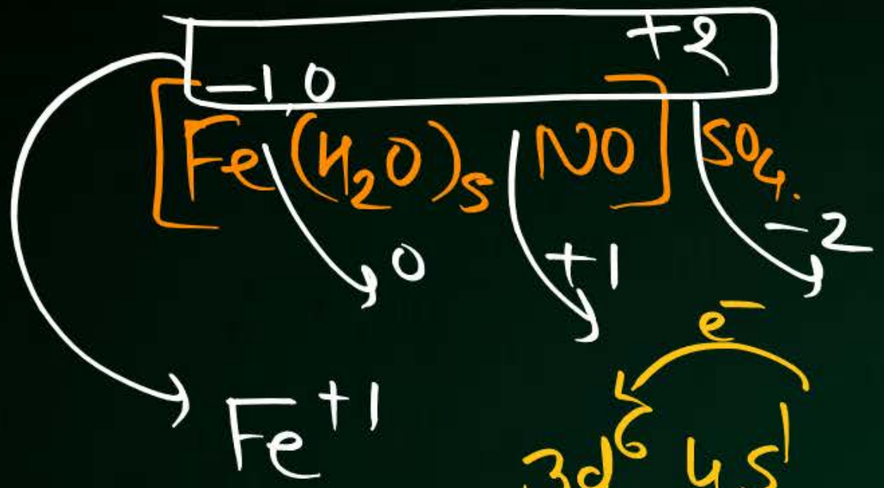
#MDJ

For
All d Block Metals

$M^{2+} \rightarrow (n-1)d^{x}\ ns^{0}\ np^{0}\ nd^{0}$

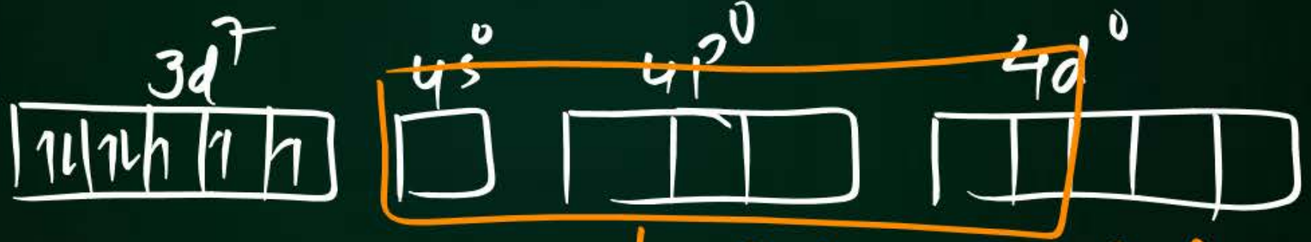
x = Serial no

S.N.	1	2	3	4	5	6	7	8	9	10
	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn



NOTE When Fe & NO are together then NO will be NO^+

$3d^7\ 4s^0\ 4p^0\ 4d^0$



↓ sp^3d^2, Octahedral

n=3, Paramagnetic

B.R.C Brown Ring Complex

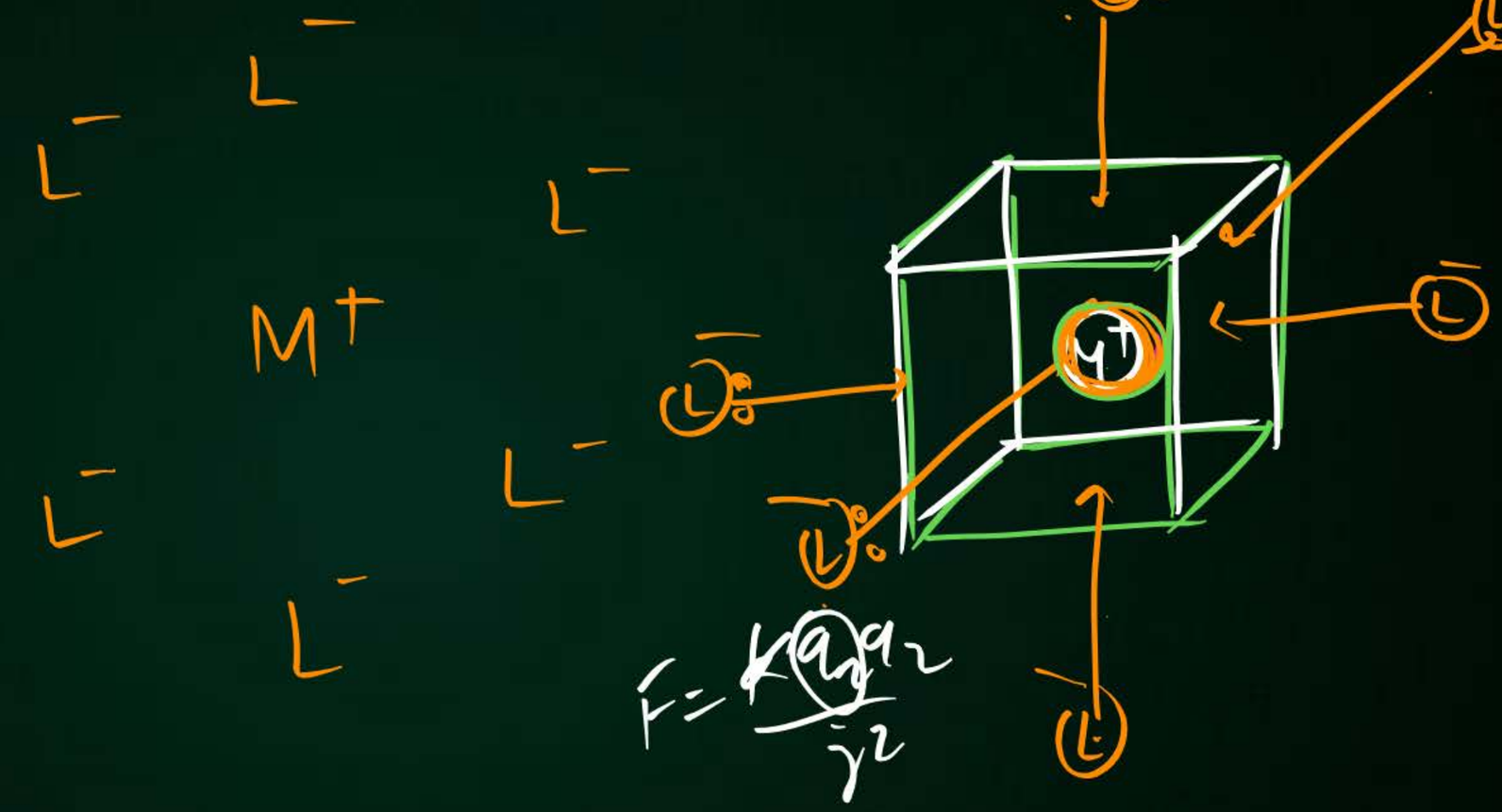
Formed during test of NO_3^- & NO_2^- ions

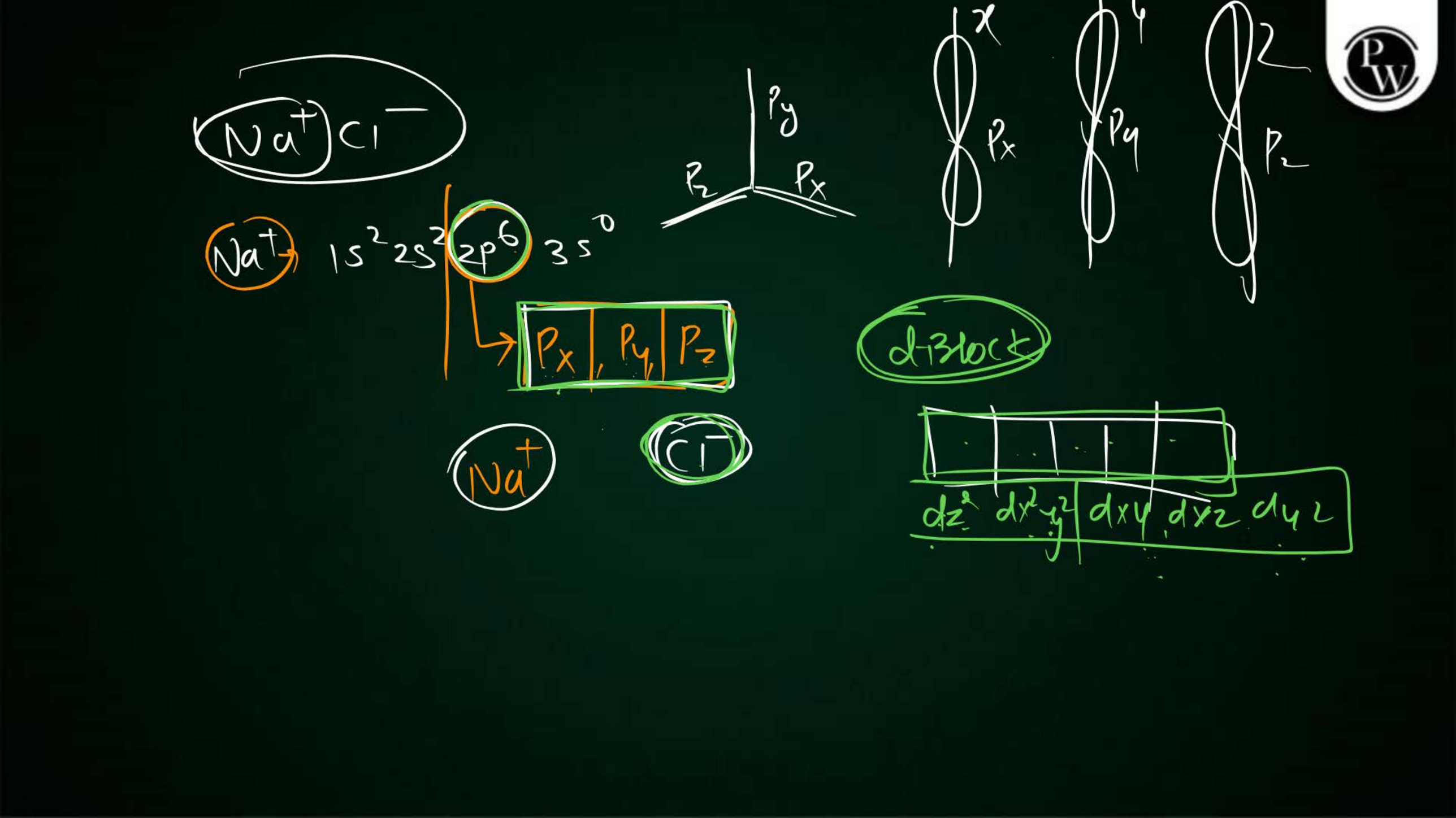
Drawbacks of VBT

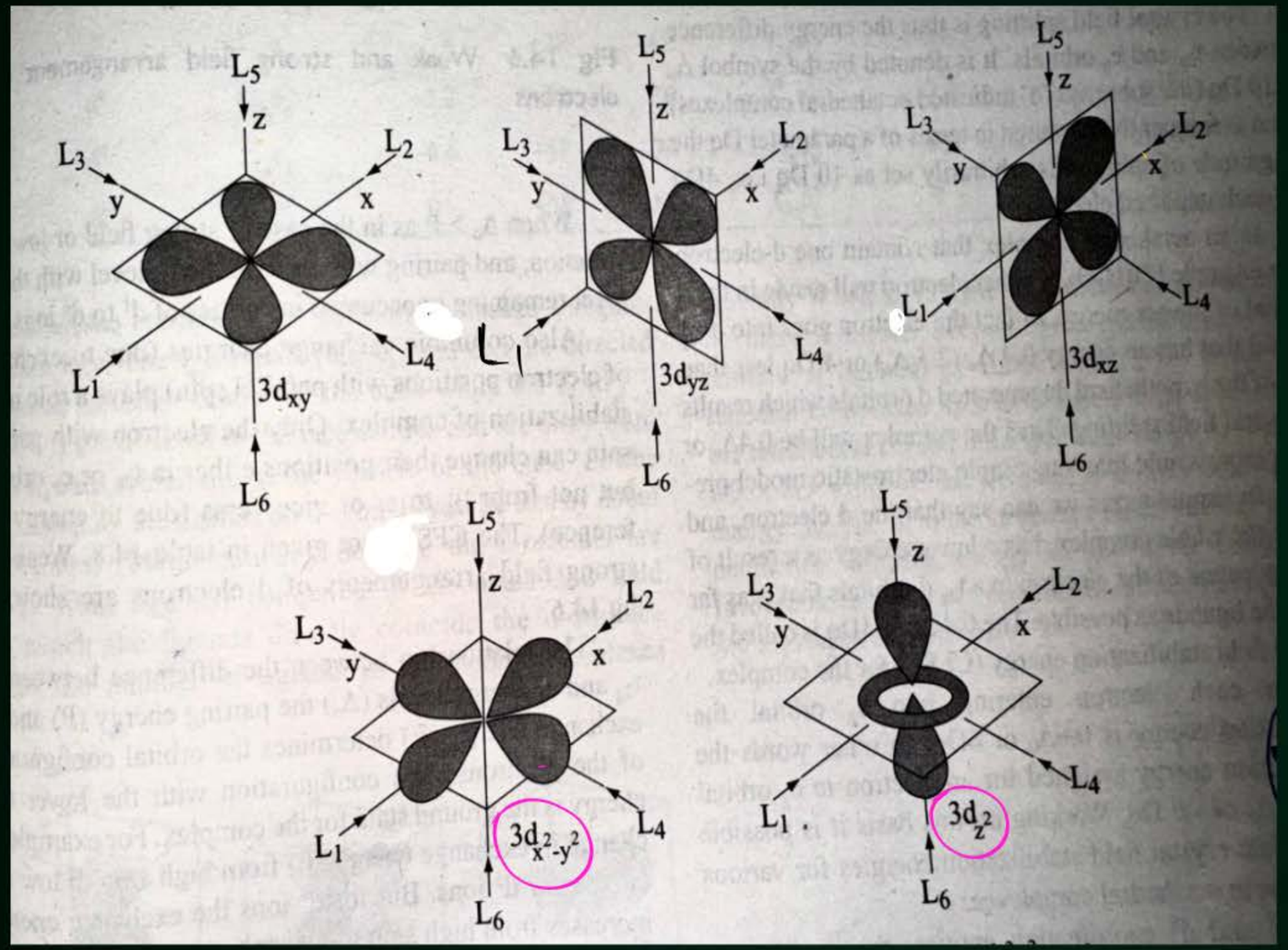
- VBT can't explain magnetic behaviour properly.
- VBT can't explain colour properly.
- VBT can't explain formation of high spin & low spin complexes.
- It does not make exact predictions regarding the tetrahedral and square planar structures of 4-coordinate complexes.
- It does not distinguish between weak and strong ligands.

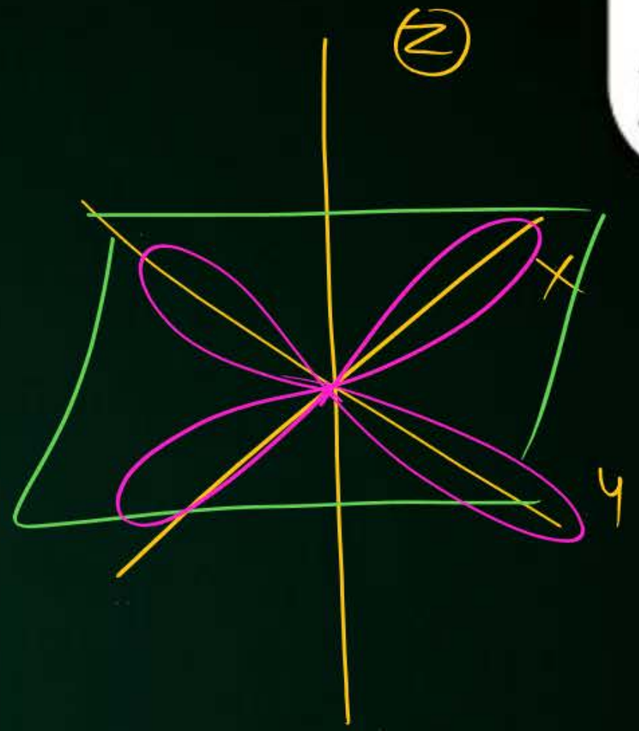
H.W

C.F.T. Crystal Field Thuory:-




Na+ Cl−
Na+ → 1s² 2s² 2p⁶ 3s⁰
Py
Pz
Px
Px Py Pz
Na+
Cl−
d-block
dz² dx²y² dxy dxz dyz


L5
z
L3
y
L2
x
L1
L4
L6
3dxy
3dyz
3dxz
3dx2-y2
3dz2

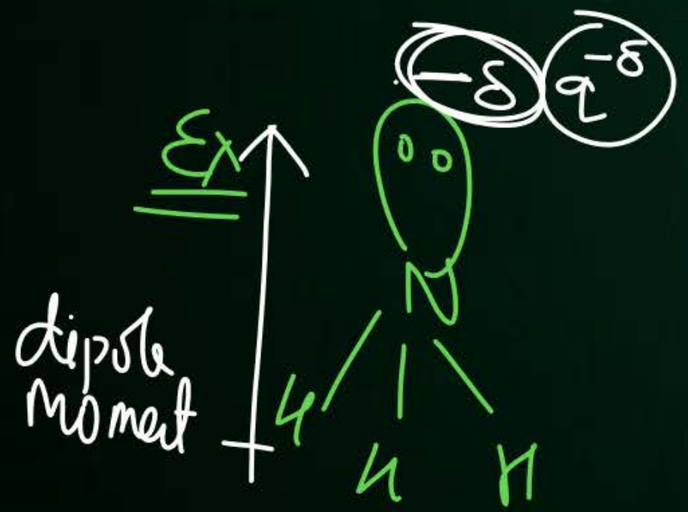

z
y
x

Crystal Field Theory

$$F = \frac{K q_1 q_2}{r^2}$$

(Assume Ionic Bond B/w Ligands & CMI)

- Based on electrostatic model.
- Consider metal cation as a point '+' charge & ligand as point '–' charge.
- When ligand approaches metal ion, energy of d-orbital increases.
- Increase in energy of d is unsymmetrical which causes splitting in d orbitals.
- Nature of splitting is depend on type of attack. & No. of ligands.



Note: in case of neutral ligands point dipole is considered as $q^{-\delta}$ $(q^{-\delta})$

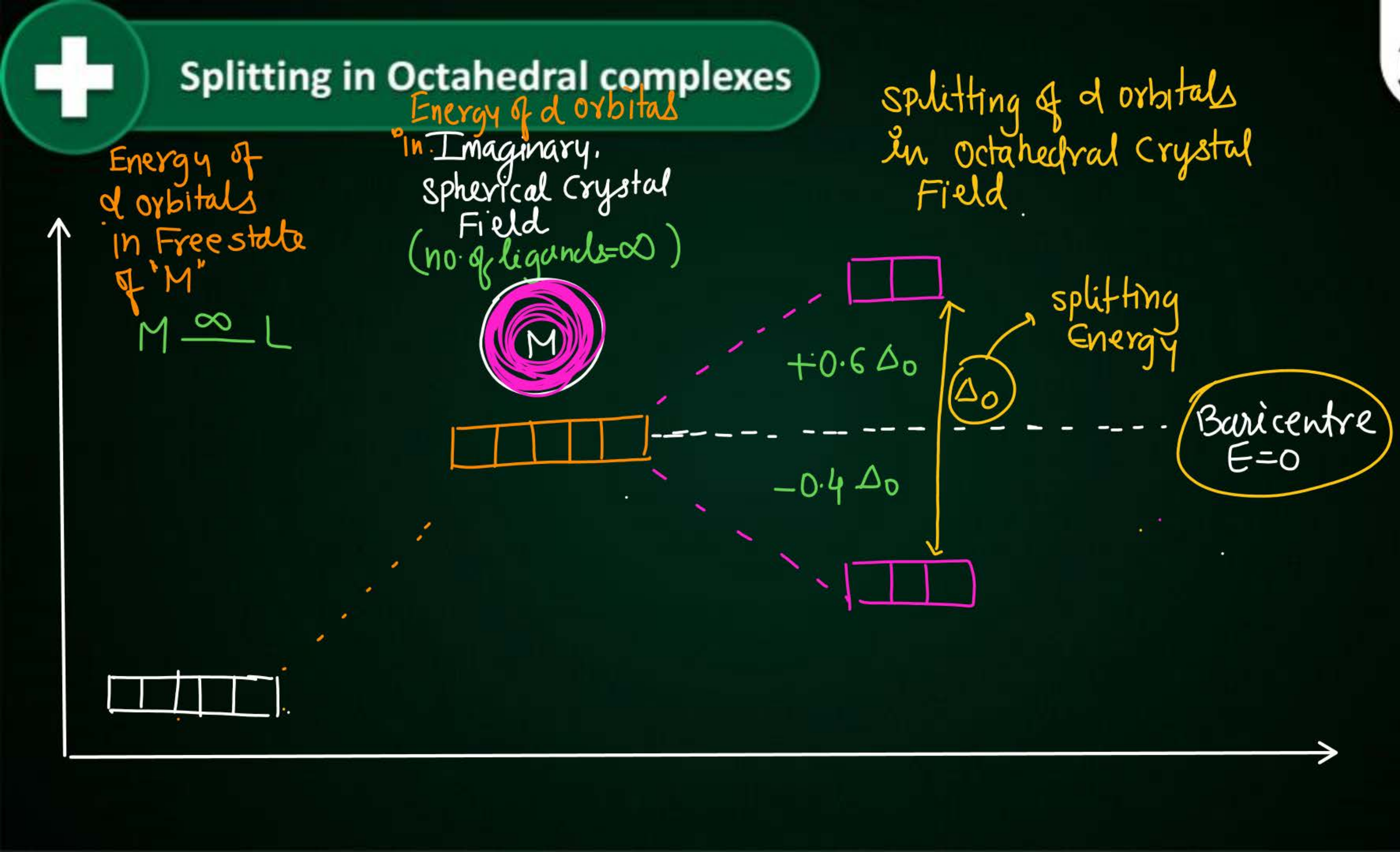
Anionic ligand → q^-	Neutral ligand → $q^{-\delta}$

Splitting in Octahedral complexes

Energy of d orbitals in Free state of 'M'

M ∞ L

Energy of d orbitals in Imaginary Spherical Crystal Field (no. of ligands = ∞)



Splitting of d orbitals in Octahedral Crystal Field

THANK YOU

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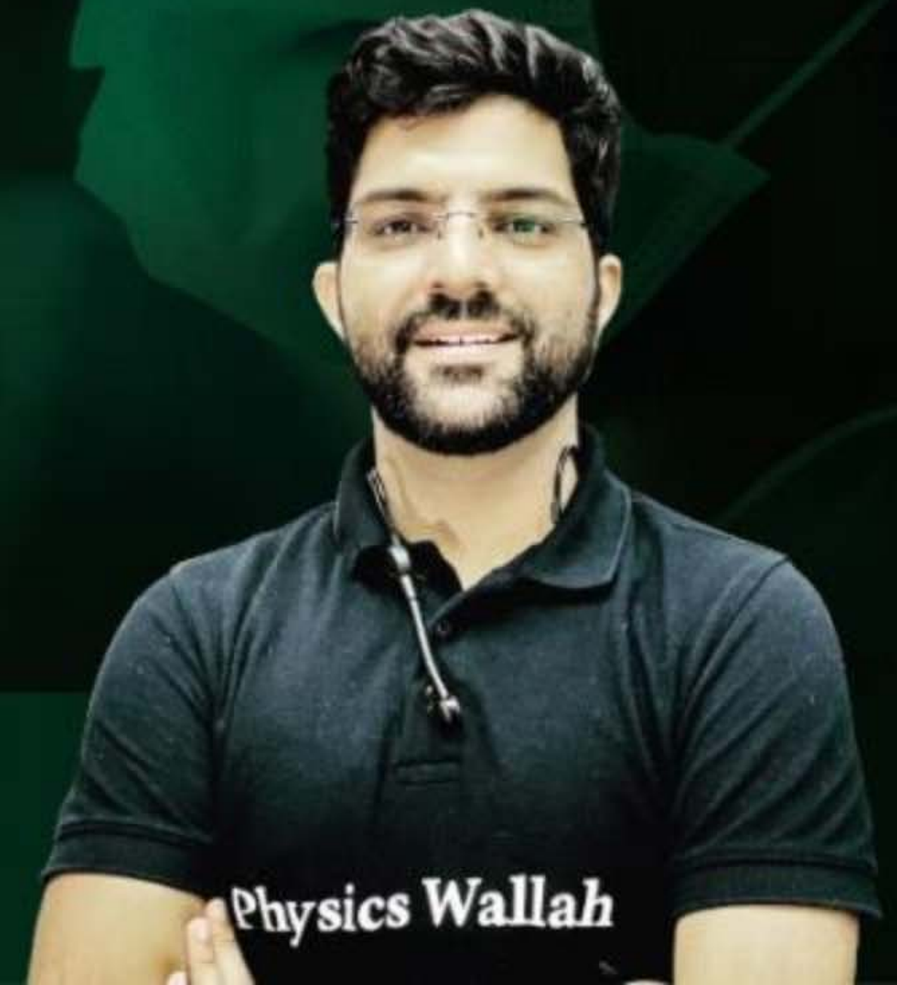
FOR NEET 2025

Lecture - 08 | Inorganic Chemistry

Coordination Compounds

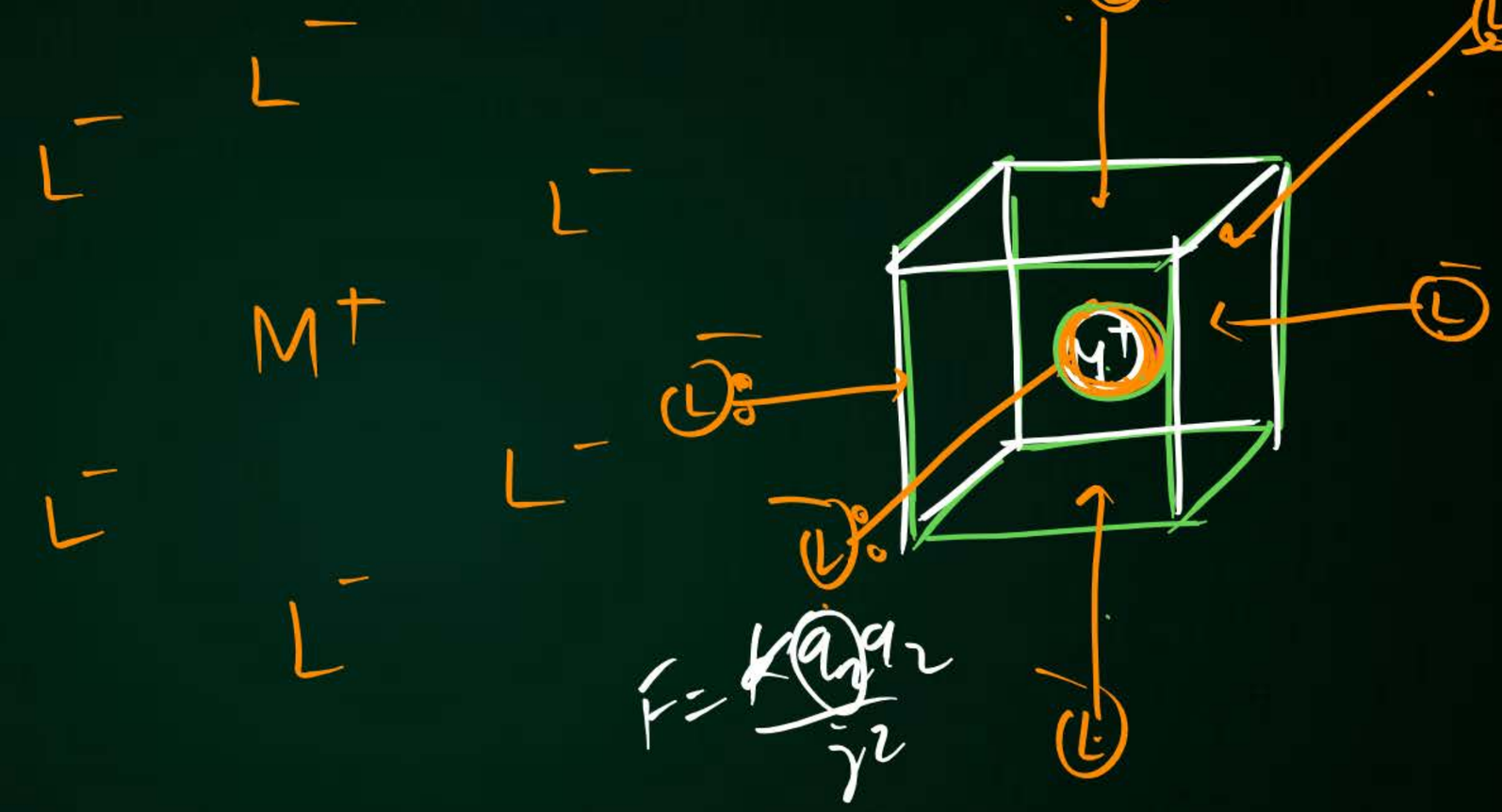


By - Mohit Dadheech (MD Sir)

Topics *to be covered*

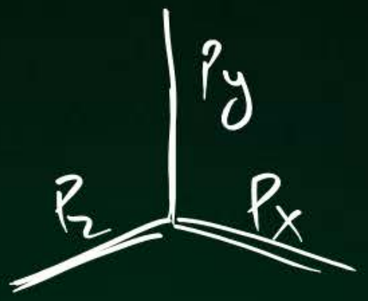
1. Crystal Field Theory (Part-II)
2.

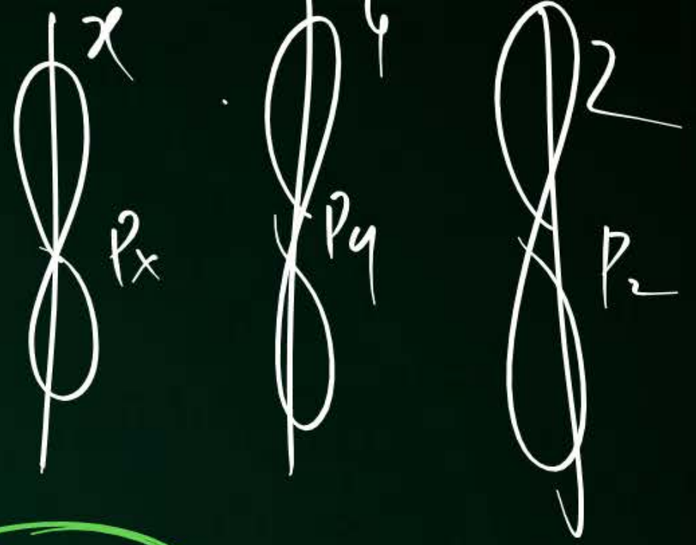
C.F.T. Crystal Field Thuory:-



$Na^+ Cl^-$

$Na^+ \rightarrow 1s^2 2s^2 2p^6 3s^0$



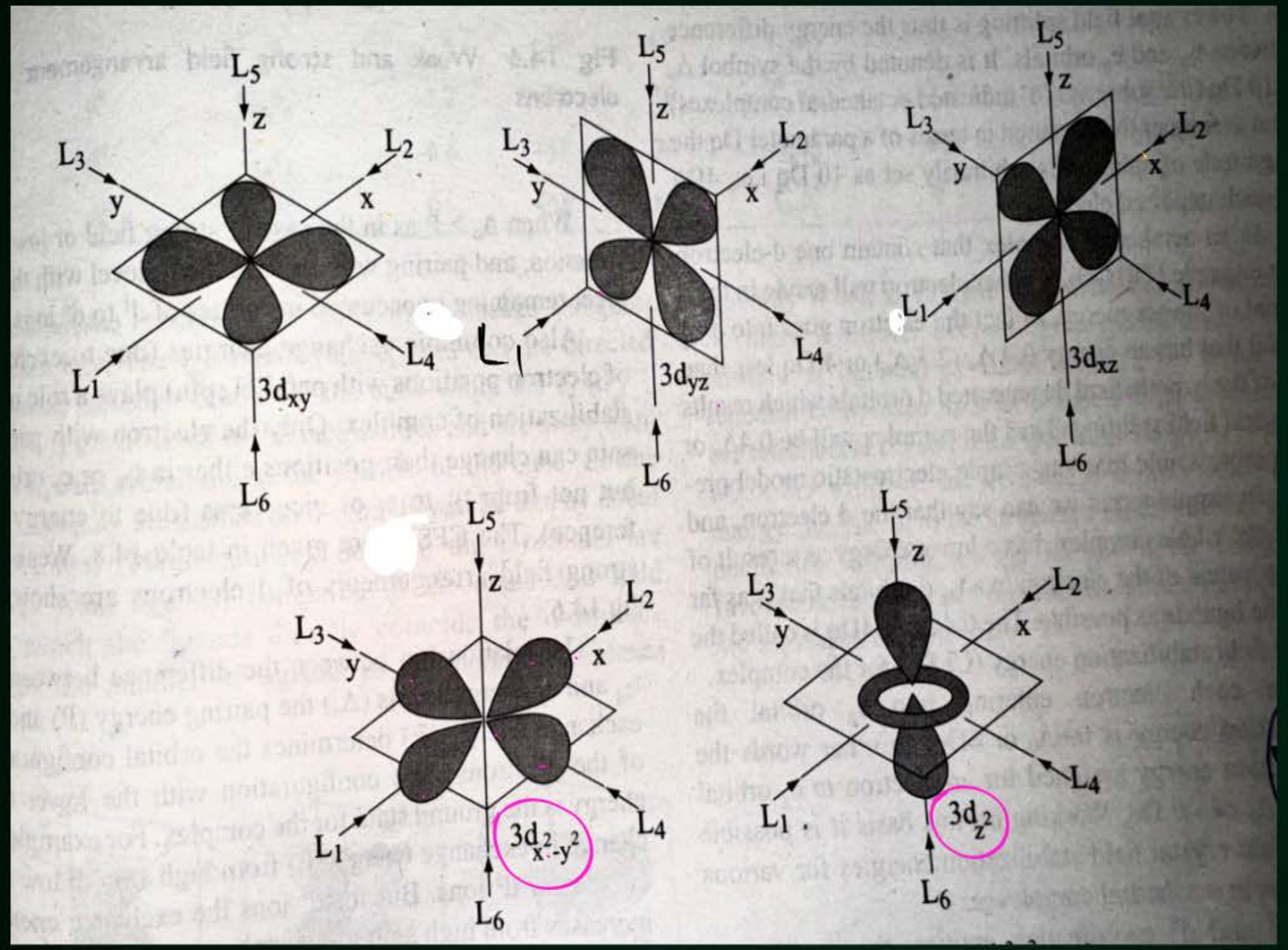


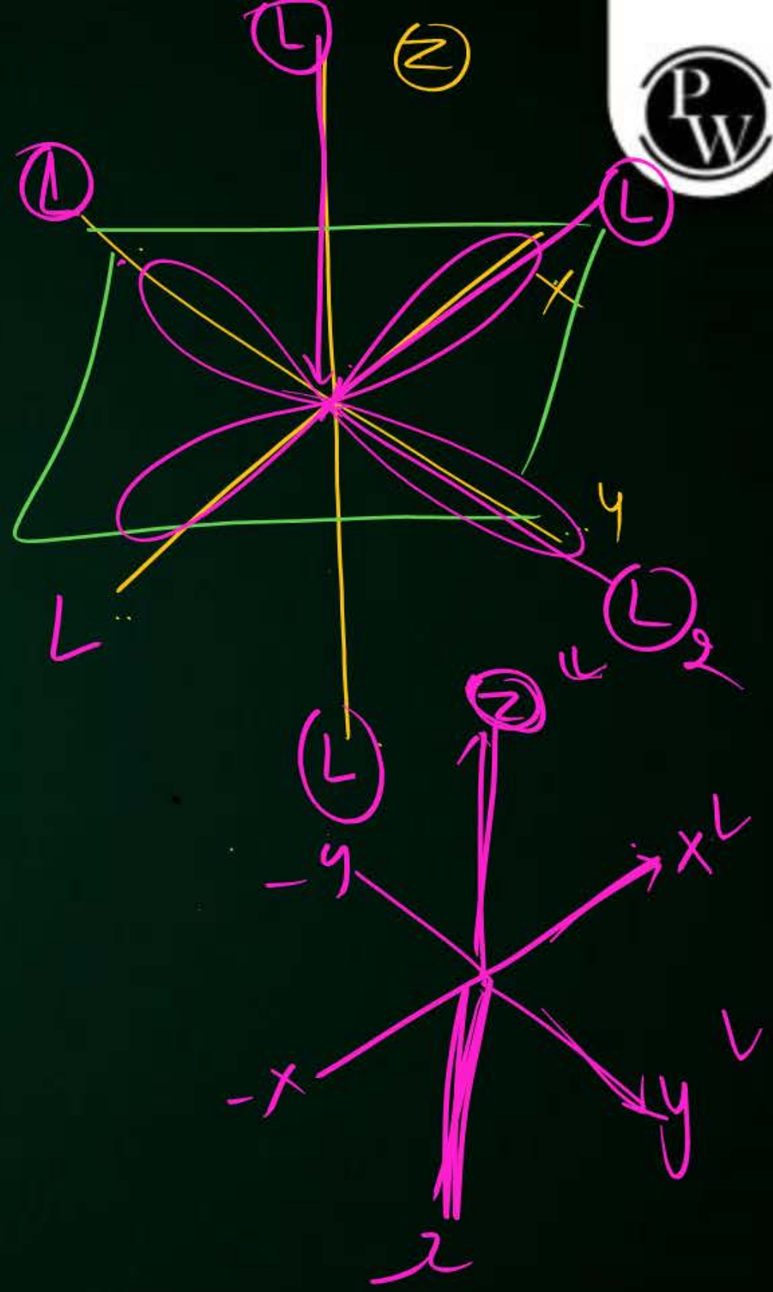
P_x	P_y	P_z

d-Block

dz^2	dx^2y^2	dxy	dxz	dyz

Na^+ Cl^-


L5
z
L3
y
L2
x
L1
L4
L6
3dxy
3dyz
3dxz
3dx2-y2
3dz2

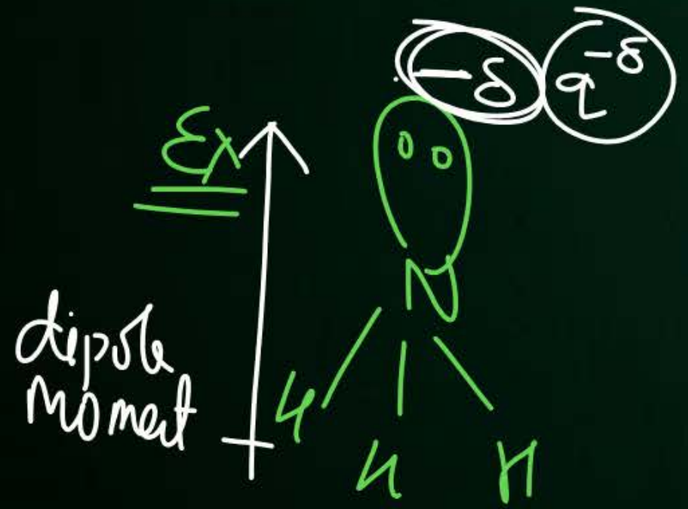

z
y
x
-y
-x

Crystal Field Theory

$$F = \frac{K q_1 q_2}{r^2}$$

(Assume Ionic Bond B/w Ligands & CMI)

- Based on electrostatic model.
- Consider metal cation as a point '+' charge & ligand as point '–' charge.
- When ligand approaches metal ion, energy of d-orbital increases.
- Increase in energy of d is unsymmetrical which causes splitting in d orbitals.
- Nature of splitting is depend on type of attack. & No. of ligands.



Note: in case of neutral ligands point dipole is considered as $q^{-\delta}$ $(q^{-\delta})$

Anionic ligand → q^-	Neutral polar → $q^{-\delta}$

Splitting in Octahedral complexes

Energy of d orbitals in Free state of "M"

M ∞ L

Energy of d orbitals in Imaginary Spherical Crystal Field (no. of ligands = ∞)

Splitting of d orbitals in (Octahedral Crystal) Field

e_g (d_{z^2}, $d_{x^2-y^2}$)

splitting Energy

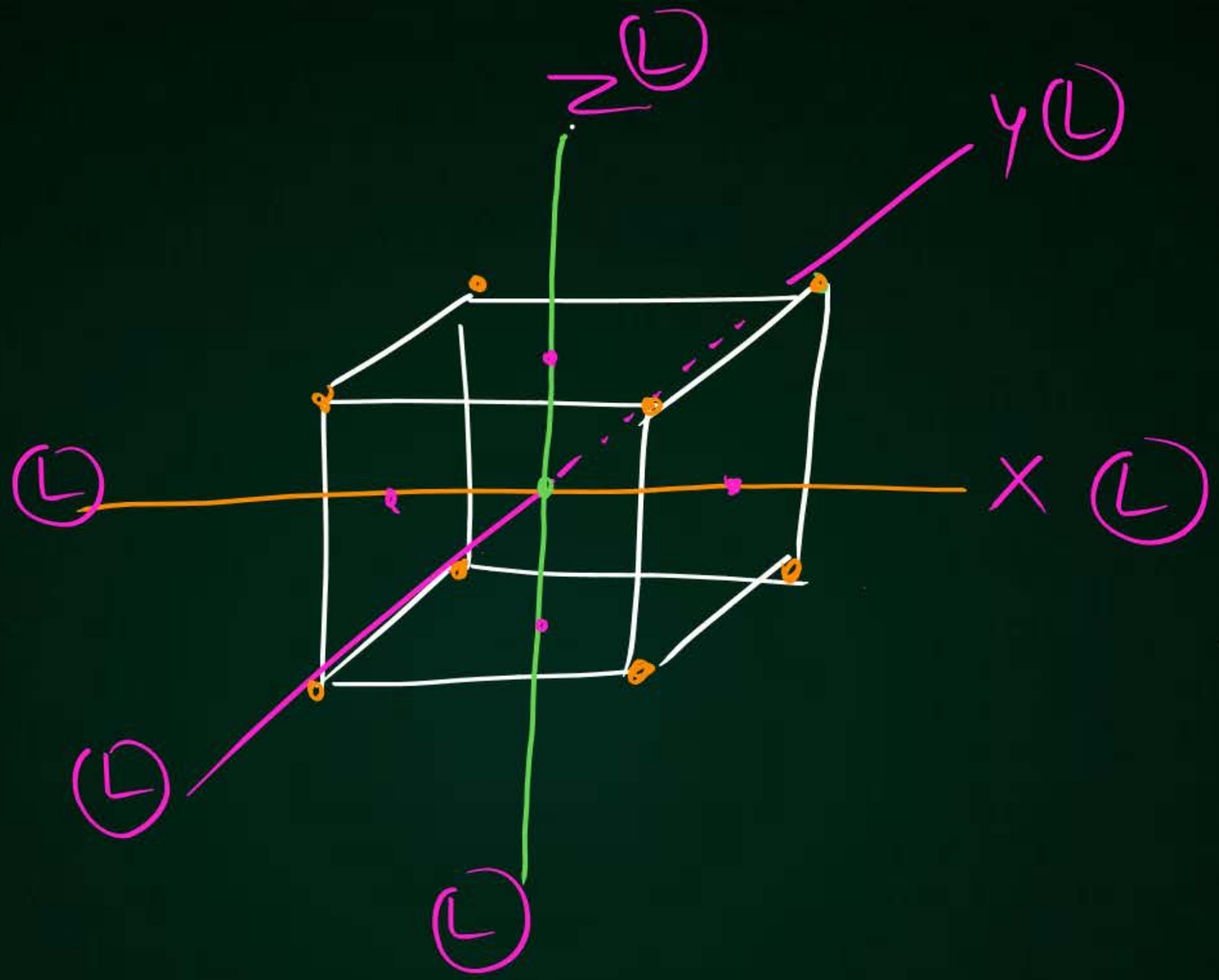
$+0.6\,\Delta_o$

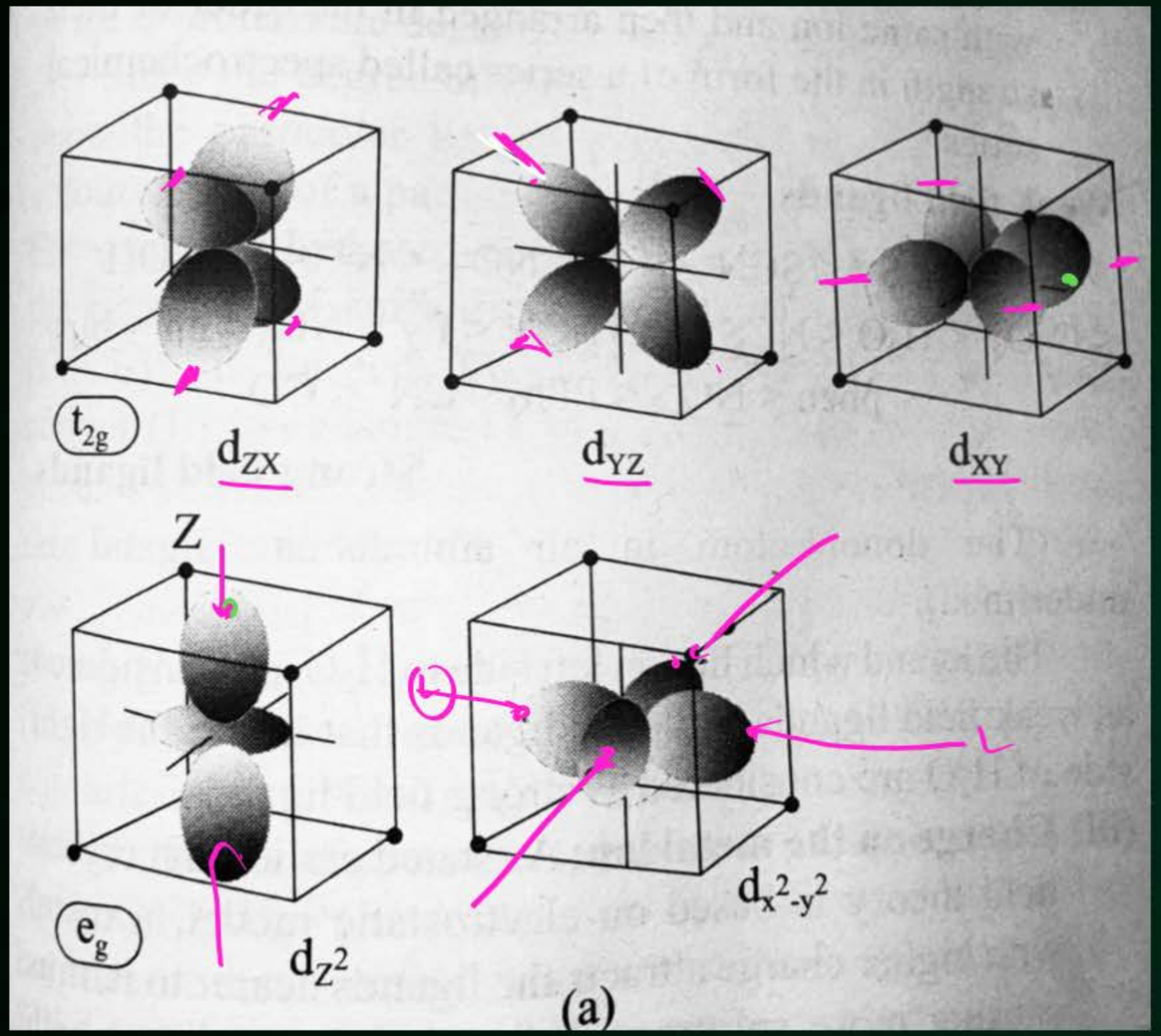
Δ_o

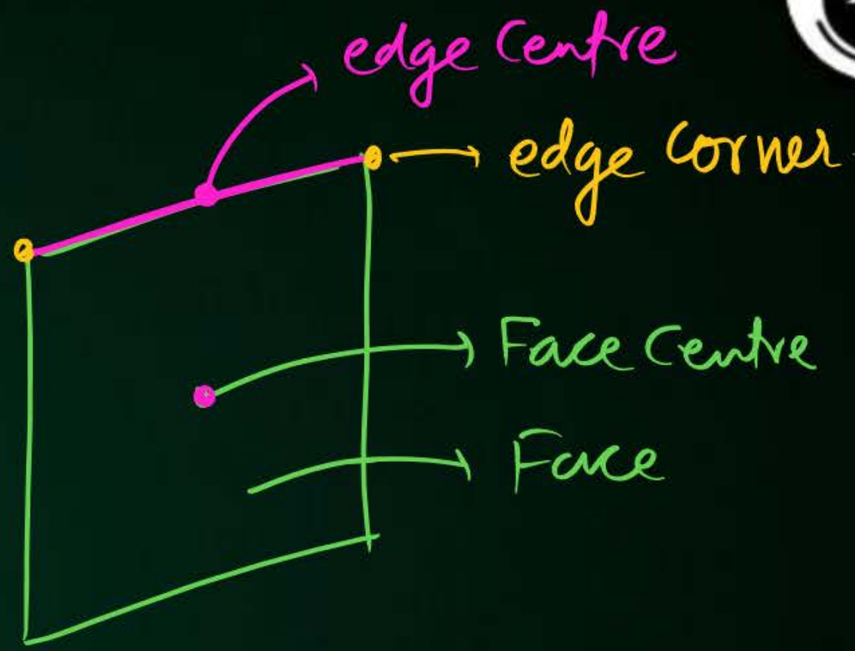
Baricentre E = 0

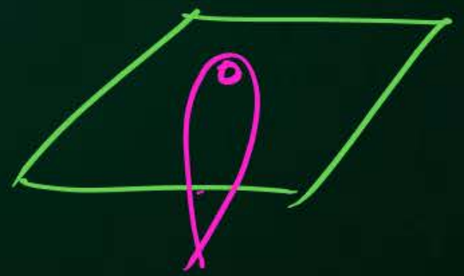
$-0.4\,\Delta_o$

t_{2g} (d_{xy}, d_{yz}, d_{xz})


Z
Y
X

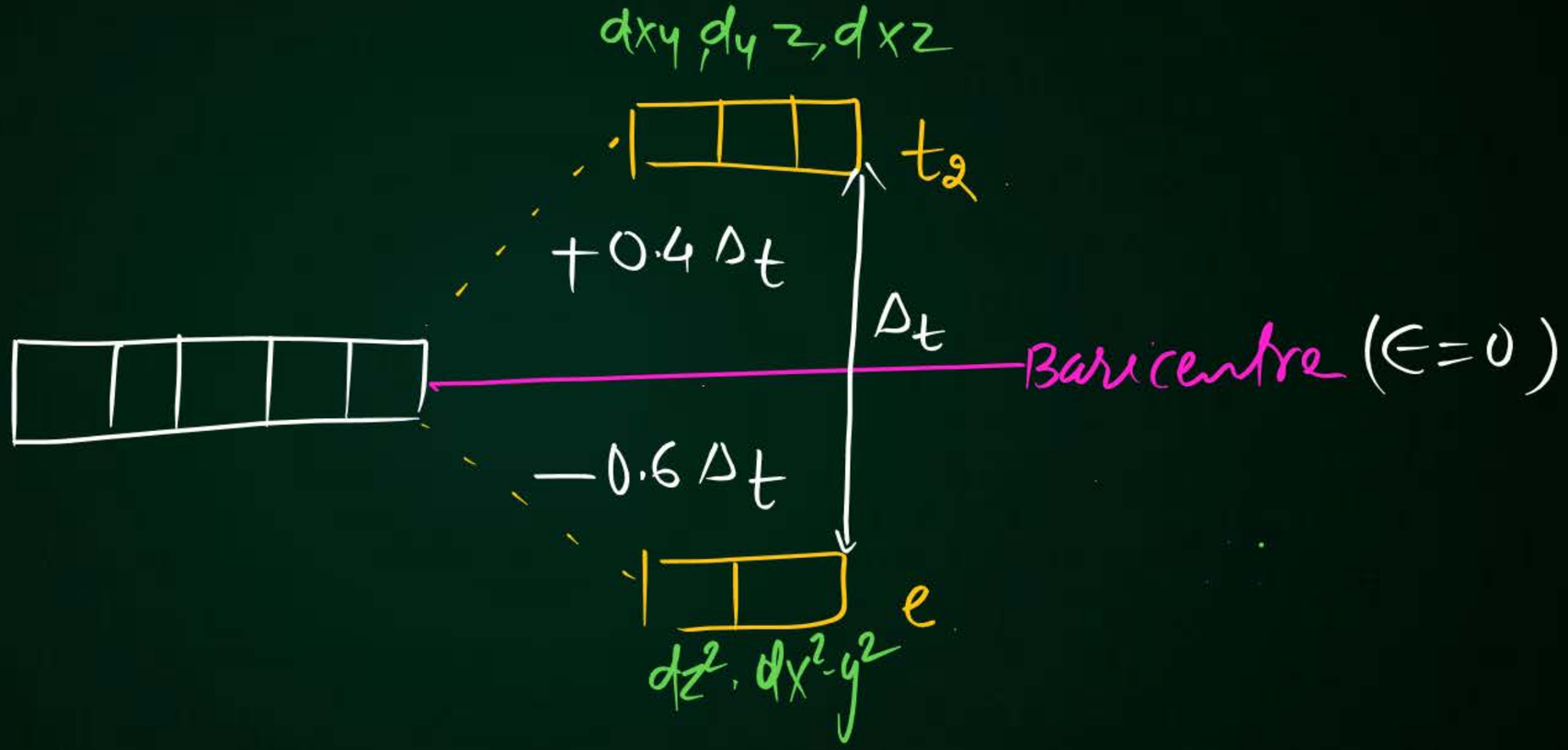

t_{2g}
d_{ZX}
d_{YZ}
d_{XY}
Z
e_g
d_{Z^2}
$d_{x^2-y^2}$
(a)


edge Centre
edge Corner
Face Centre
Face



Splitting in ~~tetra~~hedral complexes

MDJ → Octa Ka Ulta



Tetrahedral field

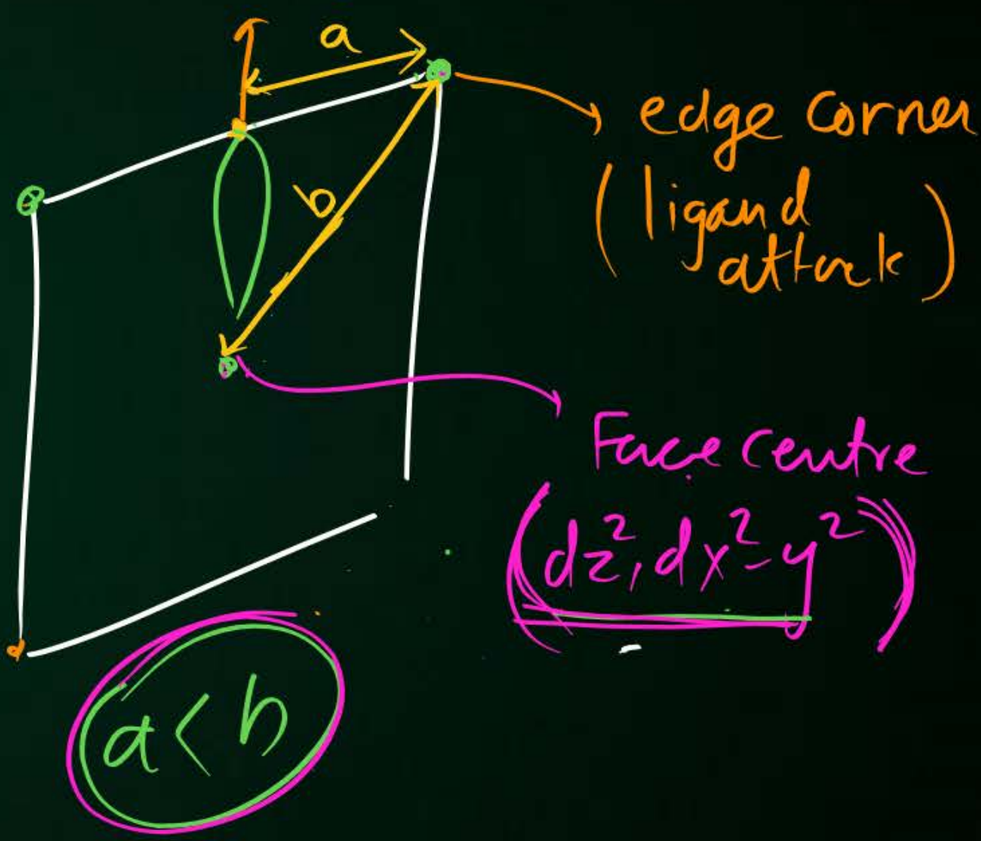
ligands attack from edge corners

(d_{xy}, d_{yz}, d_{x^2})

Edge centre

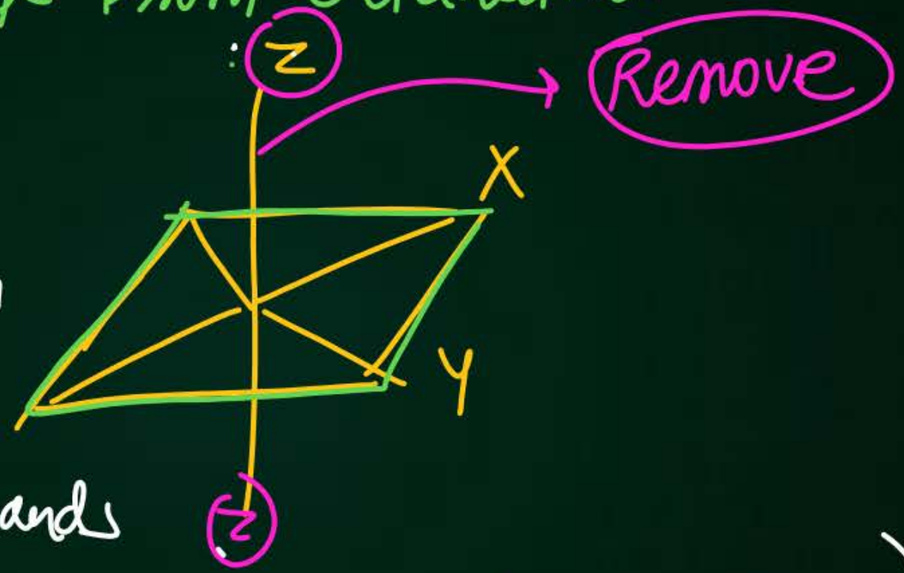
octahedral

ligands attack from face centers



Splitting in Sq planar Crystal Field :-

① according to CFT Sq. Complexes are formed by removal of z axes components from octahedral.



② when two ligands from z axis are removed then repulsion of these ligands on orbitals having z components ↓se (dz^2, dxz, dyz)

(Repulsion ↓se
energy ↓se (Lowered)
stability ↑se)

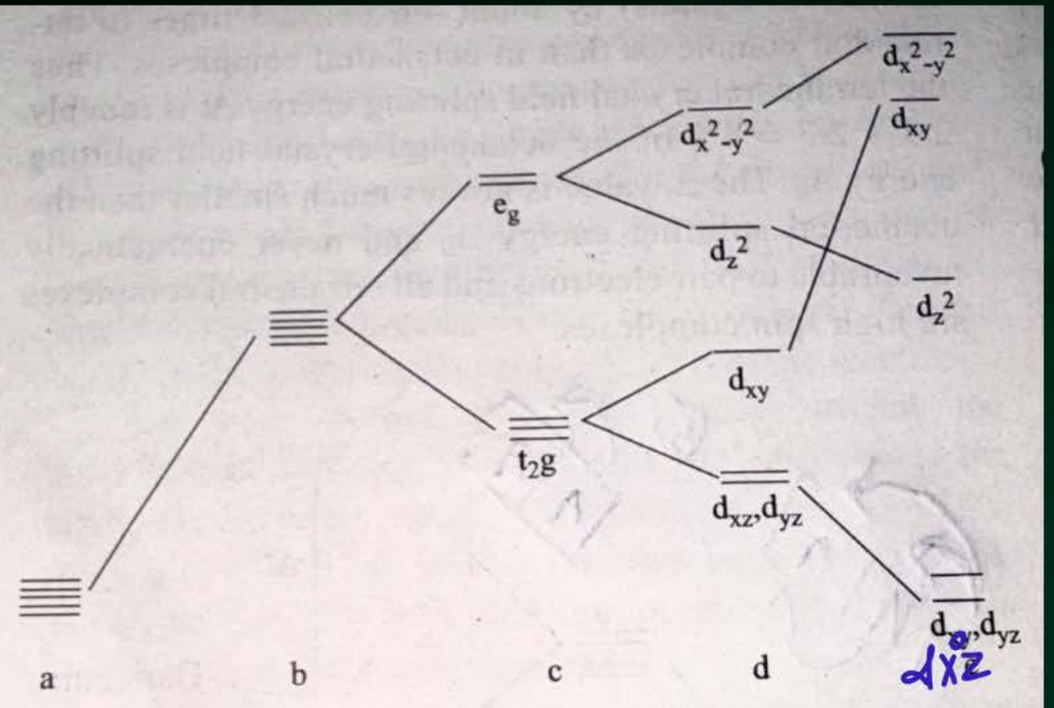


Fig 14.8 (a) d-orbital's of free ion (b) average energy of the d-orbital's in spherical crystal field (c) splitting of d-orbital's in octahedral field (d) tetragonal distortion i.e., the ligands along z axis are moving away from the metal ion (e) d-orbital splitting in square planar complex

Octa

$d_{x^2-y^2}$

$d_{z^2}, d_{x^2-y^2}$

d_{xy}

d_{z^2}

d_{xy}

d_{xy}, d_{yz}, d_{xz}

$d_{yz}\ d_{xz}$

d_{xz}, d_{yz}

Final order $d_{x^2-y^2} > d_{xy} > d_{z^2} > d_{yz} = d_{xz}$

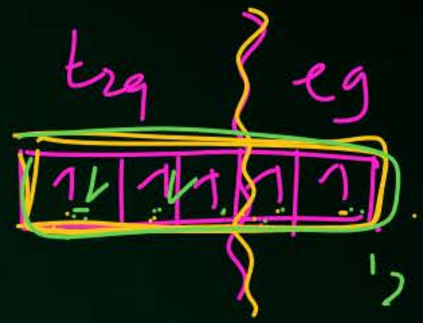
d-orbital Electronic Configuration in Octahedral complexes

$\Delta_o > P$ ⟶ Strong ligand field

$\Delta_o < P$ ⟶ Weak ligand field

Δ_o → Splitting Energy.

P → Pairing Energy.



$t_{2g}^4 e_g^0$ $t_{2g}^5 e_g^0$ $t_{2g}^6 e_g^0$ $t_{2g}^6 e_g^1$

Δ_o

d^4 [S.L] d^5 d^6 d^7

$t_{2g}^1 e_g^0$ $t_{2g}^2 e_g^0$ $t_{2g}^3 e_g$

d^1 d^2 d^3

(S.L / W.L)

$t_{2g}^3 e_g^1$ $t_{2g}^3 e_g^2$ $t_{2g}^4 e_g^2$ $t_{2g}^5 e_g^2$

d^4 [W.L] d^5 d^6 d^7

$t_{2g}^6 e_g^2$ $t_{2g}^6 e_g^3$ $t_{2g}^6 e_g^4$

d^8 d^9 d^{10}

(S.L / W.L)

MDJ

d^4 to d^7

when ① W.F.L → $t_{2g} \rightarrow e_g \rightarrow t_{2g} \rightarrow e_g$

② S.F.L → $t_{2g} \rightarrow t_{2g} \rightarrow e_g \rightarrow e_g$

Spectrochemical series

"Mainly Based on donation Strength."

Spectrochemical Series (Order of increasing field strength)

$I^- < Br^- < SCN^- < Cl^- < S^{2-} < F^- < OH^- < C_2O_4^{2-} < H_2O < NCS^- < edta^{4-} < NH_3 < py < en < dipy < NO_2^- < CN^- < CO$

SCN^- → (S donor / W.L)

NCS^- → (N donor) (S.L)

Factors affecting CFSE (Crystal field splitting energy)

1. Nature of ligand
2. Charge on CMI
3. $Z_{effective}$ of CMI (Position in periodic table)
4. Geometry
5. Chelation

1. Nature of ligand

Strength of ligand $\propto \Delta$

$K_3[FeF_6] < K_3[Fe(CN)_6]$

$[NiCl_4]^{2-} < [Ni(CN)_6]^{2-}$

2. Charge on CMI

(O.N)

Charge $\propto \Delta$

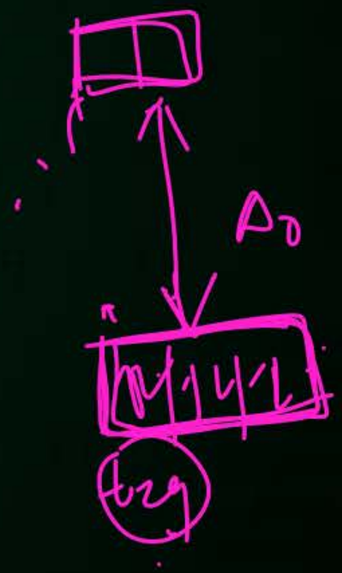
(i) $K_4[Fe(CN)_6] < K_3[Fe(CN)_6]$

Fe^{2+} Fe^{3+}

(ii) $[Fe(H_2O)_6]^{2+} < [Fe(H_2O)_6]^{3+}$

(iii) $[NiF_6]^{2-} > [NiF_6]^{4-}$

Ni^{+4} (Ni^{+2})



QUESTION

Atomic number of Mn, Fe and Co are 25, 26 and 27 respectively. Which of the following inner orbital octahedral complex ions are diamagnetic ?

(a) $[Co(NH_3)_6]^{3+}$

(b) $[Mn(CN)_6]^{3-}$

(c) $[Fe(CN)_6]^{4-}$

(d) $[Fe(CN)_6]^{3-}$

[NCERT EXEMPLAR]

1. a, c
2. a, d
3. a, b, c
4. b, d

(a) Co^{3+} d^6 $\xrightarrow{S.L}$ $t_{2g}^6 e_g^0$ $n=0$ dia

(b) Mn^{3+} d^4 $\xrightarrow{S.L}$ $t_{2g}^4 e_g^0$ $n=2$ Para

(c) Fe^{2+} d^6 $\xrightarrow{S.L}$ $t_{2g}^6 e_g^0$ $n=0$ dia

(d) Fe^{3+} d^5 $\xrightarrow{S.L}$ $t_{2g}^5 e_g^0$ $n=1$ Para.

Always

Use CFT For C.N. = 6 (Octahedral) to Save time

Use VBT for Coordination number 4 to avoid confusion b/w tetra & Sq. Plana.

QUESTION

Atomic number of Mn, Fe, Co and Ni are 25, 26, 27 and 28 respectively. Which of the following outer orbital octahedral complexes have same number of unpaired electrons?

(a) $[MnCl_6]^{3-}$ (b) $[FeF_6]^{3-}$

(c) $[CoF_6]^{3-}$ (d) $[Ni(NH_3)_6]^{2+}$

[NCERT EXEMPLAR]

1. c, d
2. a, b
3. b, c
4. a, c

QUESTION

Which of the following options are correct for $[Fe(CN)_6]^{3-}$ complex?

(a) d^2sp^3 hybridisation

(b) sp^3d^2 hybridisation

(c) paramagnetic

(d) diamagnetic

[NCERT EXEMPLAR]

H.W

1. c, d
2. a, b
3. a, c
4. a, d

QUESTION

The d-electron configuration of Cr^{2+}, Mn^{2+}, Fe^{2+} and Ni^{2+} are $3d^4$, $3d^5$, $3d^6$ and $3d^8$ respectively which one of the following aqua complexes will exhibit the minimum paramagnetic behaviour :

[AIPMT 2007]

H.W

1. $[Fe(H_2O)_6]^{2+}$
2. $[Ni(H_2O)_6]^{2+}$
3. $[Cr(H_2O)_6]^{2+}$
4. $[Mn(H_2O)_6]^{2+}$

QUESTION

Of the following complex ions, which is diamagnetic in nature ?

[AIPMT Pre. 2011]

1. $[NiCl_4]^{2-}$
2. $[Ni(CN)_4]^{2-}$
3. $[CuCl_4]^{2-}$
4. $[CoF_6]^{3-}$

QUESTION

Which of the following complex compounds will exhibit highest paramagnetic behaviour : (At. No. Ti = 22, Cr = 24, Co = 27, Zn = 30)

[AIPMT Pre. 2011]

1. $[Zn(NH_3)_6]^{2+}$
2. $[Ti(NH_3)_6]^{3+}$
3. $[Cr(NH_3)_6]^{3+}$
4. $[Co(NH_3)_6]^{3+}$

n.w

QUESTION

Which one of the following is an outer orbital complex and exhibits paramagnetic behave our ?

[AIPMT Pre. 2012]

1. $[Cr(NH_3)_6]^{3+}$
2. $[Co(NH_3)_6]^{3+}$
3. $[Ni(NH_3)_6]^{2+}$
4. $[Zn(NH_3)_6]^{2+}$

QUESTION

Which of these statements about $[Co(CN)_6]^{3-}$ is true :

[AIPMT - 2015]

1. $[Co(CN)_6]^{3-}$ has four unpaired electrons and will be in a low-spin configuration

N.W

2. $[Co(CN)_6]^{3-}$ has four unpaired electrons and will be in a high spin configuration

3. $[Co(CN)_6]^{3-}$ has no unpaired electrons and will be in a high-spin configuration

4. $[Co(CN)_6]^{3-}$ has no unpaired electrons and will be in a low-spin configuration

QUESTION

VIBT

The hybridization involved in complex $[Ni(CN)4]^{2-}$ is (At. No. NI = 28)

[Re-AIPMT - 2015]

H.W

1. d^2sp^2
2. d^2sp^3
3. dsp^2
4. sp^3

QUESTION

Which one of the following complexes is an outer orbital complex ?
(At. nos. Mn = 22, Fe = 26, Co = 27, Ni = 28) [AIEEE - 2004]

1. $[Fe(CN)_6]^{4-}$

2. $[Mn(CN)_6]^{4-}$

3. $[Co(NH_3)_6]^{3+}$

4. $[Ni(NH_3)_6]^{2+}$

n·w

The correct order of magnetic moments (spin only values in BM) among the following is : (At. nos. Mn = 25, Fe = 26, Co = 27)

[AIEEE - 2004]

$[MCl_4]^{2-} > [CoCl_4]^{2-} > [Fe(CN)_6]^{4-}$

n

n·w

$[MnCl_4]^{2-} > [Fe(CN)_6]^{4-} > [CoCl_4]^{2-}$

$[Fe(CN)_6]^{4-} > [MnCl_4]^{2-} > [CoCl_4]^{2-}$

$[Fe(CN)_6]^{4-} > [CoCl_4]^{2-} > [MnCl_4]^{2-}$

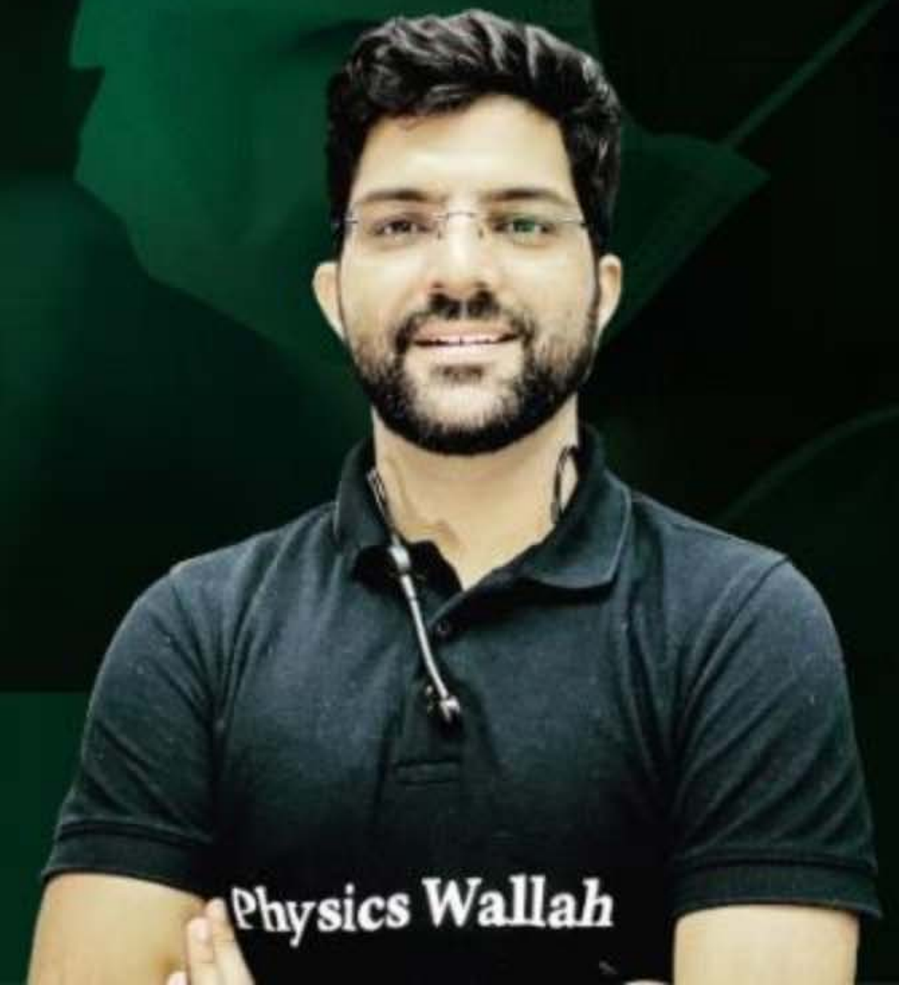
THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture -09 | Inorganic Chemistry

Coordination Compounds



By - Mohit Dadheech (MD Sir)

Topics *to be covered*

1. Colour in Complexes
2. Calculation of CFSE

2. Charge on CMI

(O.N.)

Charge on CMI $\propto \Delta$

(i) $K_3[Fe(CN)_6] > K_4[Fe(CN)_6]$

Fe^{3+} $\quad$ Fe^{2+}

(ii) $[NiF_6]^{2-} > [NiF_6]^{4-}$

(Ni^{+4}) $\quad$ (Ni^{+2})

(iii) $[Fe(H_2O)_6]^{3+} > [Fe(H_2O)_6]^{2+}$

(3) Zeff on CMI

Position of Transition series (3d / 4d / 5d)

3d ↓ 4d ↓ 5d

Zeff ↑se

+s ↑se on CMI

Δ ↑se

(ii) $[Fe(H_2O)_6]^{2+} < [Ru(H_2O)]^{2+} < [Os(H_2O)_6]^{2+}$

sp^3d^2

$t_{2g}^4 e_g^2$

d^2sp^3

$t_{2g}^6 e_g^0$

(ii) $[NiCl_4]^{2-} < [PdCl_4]^{2-} < [PtCl_4]^{2-}$

3d — sp^3 — tetra

4d — dsp^2

5d — dsp^2

sq. planar

(4) geometry of Complex

$\Delta_t = \frac{4}{9}\Delta_o$

or

$\Delta_o = \frac{9}{4}\Delta_t$

$\Delta_{sp} = 1.33\,\Delta_o$

$\times$ 1.33 to 1.7

$\Delta\uparrow$ stability

Inform of Released Energy

$\Delta_t < \Delta_o < \Delta_{sp}$

Ex. (i)

$[NiCl_4]^{2-}$ (tetra, sp^3) $<$ $[Ni(CN)_4]^{2-}$ (Sq. planar)

(ii) $[Cu(NH_3)_4]^{2+}$ (sq. planar, dsp^2) $>$ $[CuCl_4]^{2-}$ (sp^3)

Q If Δ_o of $[CoCl_6]^{4-}$ is 18000 cm^{-1} then Find Δ_t for $[CoCl_4]^{2-}$

NCERT exemplar

$$\Delta_t = \frac{4}{9}\Delta_o$$

$$= \frac{4}{9} \times 18000 = 8000\ cm^{-1}$$

(iii) $[Ni(CN)_6]^{4-}$ < $[Ni(CN)_4]^{2-}$

$\Delta_{sp} = 1.33\,\Delta_o$

Octa.
Δ_o

S.P
Δ_{sp}

⑤ (Ring Formation)

Chelation ∝ stability

no. of rings ∝ stability

(i) $[Ni(H_2O)_6]^{2+} < [Ni(en)_3]^{2+}$

(ii) $[Co(H_2O)_6]^{3+} < [Co(C_2O_4)_3]^{3-}$

(iii) $[NiCl_4]^{2-} < [Ni(dmg)_2]$

(iv) $[Co(trien)]^{3+} > [Co(en)_2]^{3+}$

More no. of rings

give Correct order of stability :—

(1) $[NiF_6]^{4-} < [NiF_6]^{2-}$

(2) $[Fe(CN)_6]^{4-} < [Fe(CN)_6]^{3-}$

(3) $[Co(NH_3)_6]^{3+} < [Co(en)_3]^{3+}$

④ $[Co(CN)_6]^{3-} > [Co(H_2O)_6]^{3+} > [Co(C_2O_4)_3]^{3-} > [CoF_6]^{3-}$

⑤ $[\overset{0}{Co}(H_2O)_6]^{3+} > [\overset{+3}{Co}(H_2O)_3F_3]^{0}$

⑥ $[Fe(CN)_6]^{3-} > [Fe(NO_2)_6]^{3-} > [Fe(H_2O)_6]^{3+}$

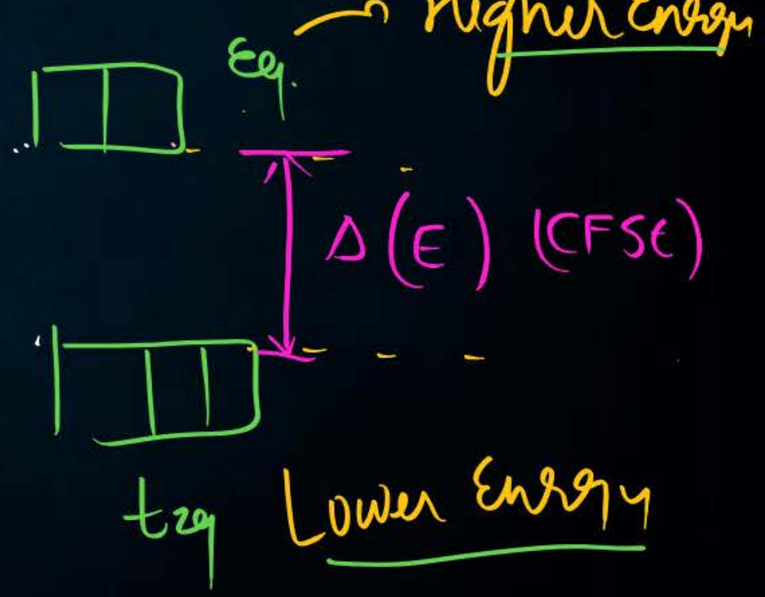
Colour in complexes

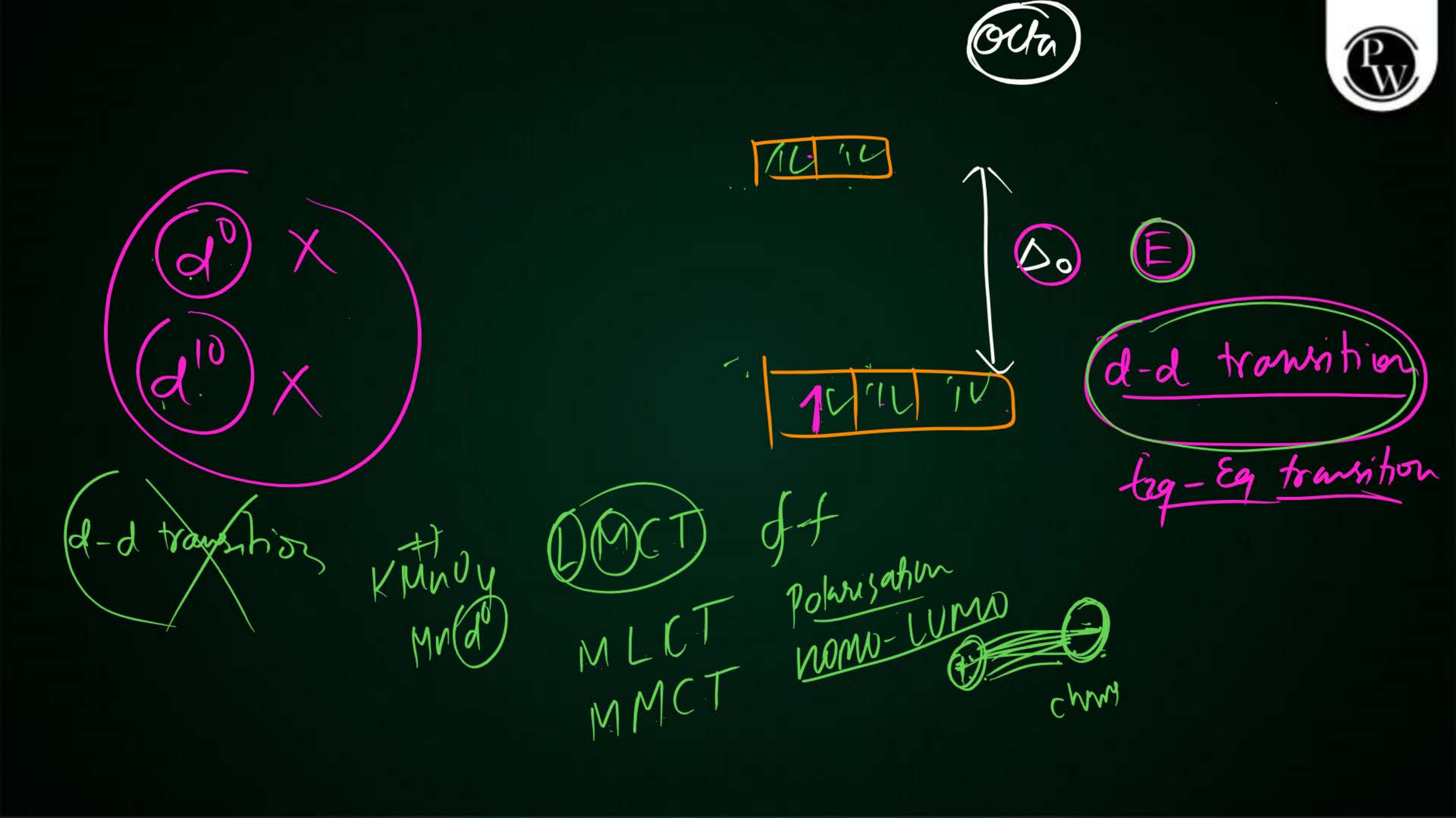
CFT Explain Colour in Complexes on the basis of d-d transition (t_{2g} - e_g transition)

* "gen." Complexes are coloured due to d-d transition.

* NOTE For d^0 & d^{10} d-d transition is not Possible.

Splitting




Octa
d^0 X
d^{10} X
Δ_o
E
d-d transition
tag - Eq transition
d-d transition
KMnO4
Mn(d^0)
LMCT
MLCT
MMCT
Polarisation
HOMO-LUMO
chem

$E = h\nu$

$\nu = \frac{c}{\lambda}$

$E = \frac{hc}{\lambda}$

(*) $E \propto \frac{1}{\lambda}$ (λ absorbed)

$E = \Delta = CFSE$

(A) $[Co(en)_3]^{3+}$

(B) $[Co(H_2O)_3]^{3+}$

(C) $[CoF_6]^{3-}$

ligand strength ↑

Δ ↑ (E ↑)

λ ↓

order of Energy → A > B > C

order of λ absorbed A < B < C

QUESTION

Correct increasing order for the wavelengths of absorption in the visible region for the complexes of Co^{3+} is

1. $[Co(H_2O)_6]^{3+}$, $[Co(en)_3]^{3+}$, $[Co(NH_3)_6]^{3+}$
2. $[Co(H_2O)_6]^{3+}$, $[Co(NH_3)_6]^{3+}$, $[Co(en)_3]^{3+}$
3. $[Co(NH_3)_6]^{3+}$, $[Co(en)_3]^{3+}$, $[Co(H_2O)_6]^{3+}$
4. $[Co(en)_3]^{3+}$, $[Co(NH_3)_6]^{3+}$, $[Co(H_2O)_6]^{3+}$

NOTE

Colour in Complex is Complementry to that which is absorbed.

VI B G Y O R

$\lambda_{absorbed}$ ↑ se E ↓ se

(Low λ_{ab})

Strong ligand. High Energy wala Colour absorb Karta Hai!!

QUESTION

The octahedral complex of a metal ion M^{3+} with four monodentate ligands L_1, L_2, L_3 and L_4 absorbs wavelengths in the region of red, green, yellow and blue, respectively. The increasing order of ligand strength of the four ligands is

1. $L_1 < L_2 < L_4 < L_3$
2. $L_4 < L_3 < L_2 < L_1$
3. $L_1 < L_3 < L_2 < L_4$
4. $L_3 < L_2 < L_4 < L_1$

#MDD

Absorbed Colour

L_1 Red

L_2 green

L_3 yellow

L_4 Blue

Strong ligand High Energy (Low λ)

Violet Colour absorb Karta hai

VIBGYOR

$\lambda \uparrow$ $E \downarrow$

QUESTION

$[Co(CN)_6]^{3-}$, a complex ion of cobalt (III), absorbs radiations in violet region of the visible light. Its aqueous solution, therefore, appears

(VI)

1. Pink
2. Orange
3. Blue
4. Yellow

(VI) B G Y O R

QUESTION

The colourless species is

1. VCl_3 V^{3+}
2. VSO_4 V^{2+}
3. Na_3VO_4 V^{+5} (d^0)
4. $[V(H_2O)_6]\,SO_4 \cdot H_2O$ V^{2+}

Hint d^0, d^{10} colourless

QUESTION

Which of the following complex ions is expected to absorb visible light?

[AIPMT 2009]

1. $[Zn(NH_3)_6]^{2+}$ d^{10}

2. $[Sc(H_2O)_3(NH_3)_3]^{3+}$ Sc^{3+} d^0

3. $[Ti(en)_2(NH_3)_2]^{4+}$ Ti^{+4} d^0

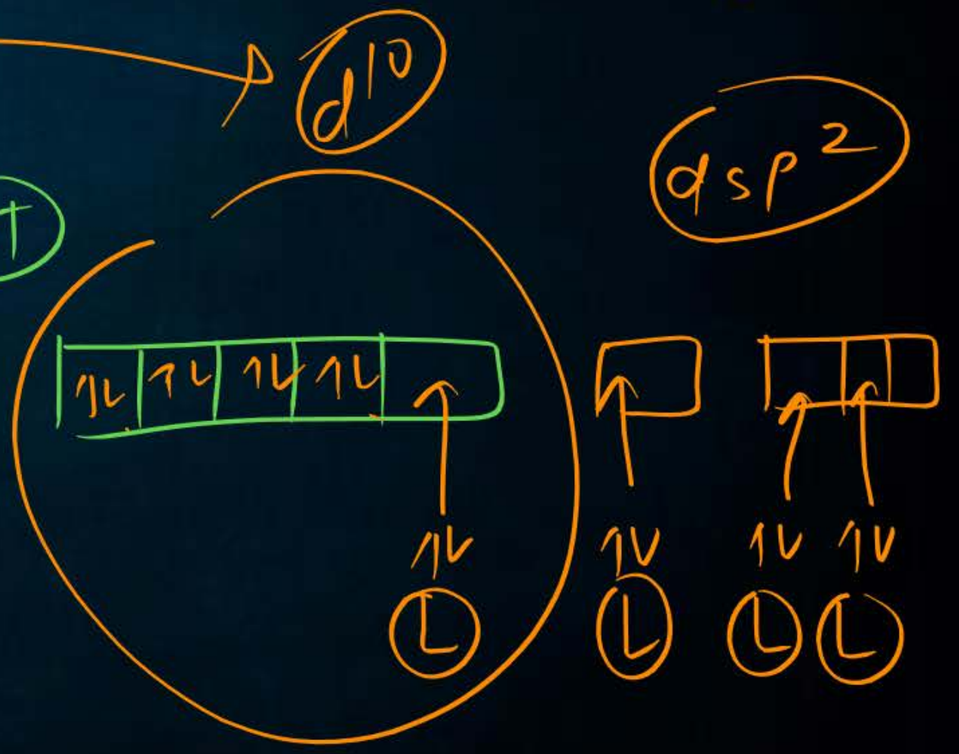
4. $[Cr(NH_3)_6]^{3+}$ Cr^{3+} d^3

QUESTION

Which of the following complex ion is not expected to absorb visible light ?

[AIPMT 2010]

1. $[Ni(H_2O)_6]^{2+}$ (d^8) ✓
2. $[Ni(CN)_4]^{2-}$ → d^8 → dsp^2 → V.B.T → d^{10} → dsp^2
3. $[Cr(NH_3)_6]^{3+}$ (d^3)
4. $[Fe(H_2O)_6]^{2+}$ (d^6 W.L → $t_{2g}^4 e_g^2$)



QUESTION

Out of TiF_6^{2-}, CoF_6^{3-}, Cu_2Cl_2 and $NiCl_4^{2-}$ colourless species are :

[AIPMT 2009]

1. CoF_6^{3-} and $NiCl_4^{2-}$
2. TiF_6^{2-} and CoF_6^{2-}
3. TiF_6^{2-} and CoF_6^{2-}
4. TiF_6^{2-} and Cu_2Cl_2

NOTE

① $[Ti(H_2O)_6]Cl_3 \xrightarrow{\Delta} TiCl_3$

Complex

d^3

d-d transition

Purple / Violet

Anhydrous Salt

d-d ~~transition~~

(Colourless)

② $CuSO_4 \cdot 5H_2O \xrightarrow{\Delta} CuSO_4$

d-d-Transition ✓

Blue colour

Anhydrous

~~d-d~~

Colourless

NOTE

Colour of gem stones like Colour of Ruby & emerald
(Red) (green)

Imp

is due to Cr^{3+} (d^3) ions (d-d transition)

Ruby (Al_2O_3) Contains 0.5 to 1% Cr^{3+} ions.

Emerald. [$Be_3Al_2Si_6O_{18}$] Contains Cr^{3+} ions
Beryl

Effect of ligand strength on Colour :—

NCERT Example

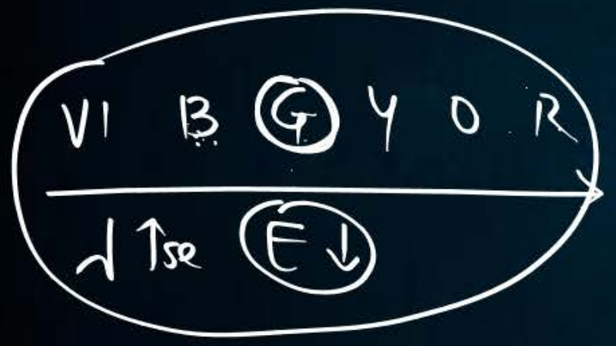
Ex

S.F.L

"en"

⇒ If the didentate ligand "en" is progressively added in molar ratio [en : Ni]

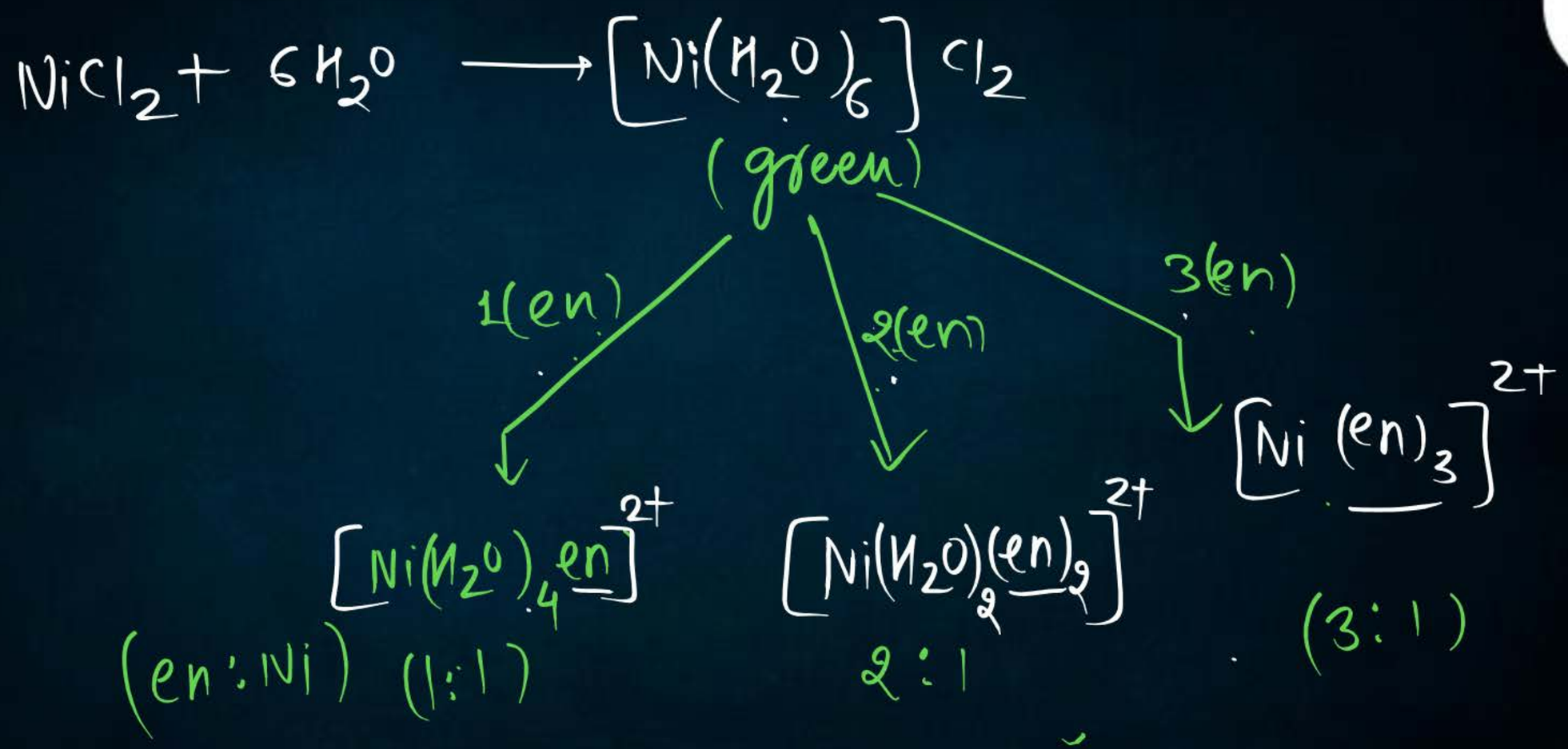
1 : 1, 2 : 1, 3 : 1, change in colour occurs as follow :—



$$\underset{\text{(green)}}{[Ni(H_2O)_6]^{2+}} + en \longrightarrow \underset{(1:1)}{[Ni(H_2O)_4 en]^{2+}} \quad \text{Pale Blue}$$

$$[Ni(H_2O)_4 en] + en \longrightarrow \underset{(2:1)}{[Ni(H_2O)_2(en)_2]} \quad \text{Blue}$$

$$[Ni(H_2O)_2(en)_2] + en \longrightarrow \underset{(3:1)}{[Ni(en)_3]^{2+}} \quad \text{Violet}$$


NiCl2 + 6H2O → [Ni(H2O)6] Cl2
(green)
1(en)
2(en)
3(en)
[Ni(H2O)4en]2+
[Ni(H2O)2(en)2]2+
[Ni(en)3]2+
(en : Ni)
(1:1)
2:1
(3:1)

Que Correct Match

Complex	Reflected (Colour)	Absorbed Colour
(A) $M(en)_3$	(i) Blue	orange — Absorbed by (B)
(B) $M(H_2O)_6$	(ii) green	Red — Absorbed by (C)
(C) $M(F)_6$	(iii) yellow	Violet — Absorbed by (A)

VI B G Y O R

$\lambda \uparrow \quad E \downarrow$

Que

Correct Match

Colour Absorbed.

Home -work

(A) $[Ni(H_2O)_6]^{2+}$ (i) VI

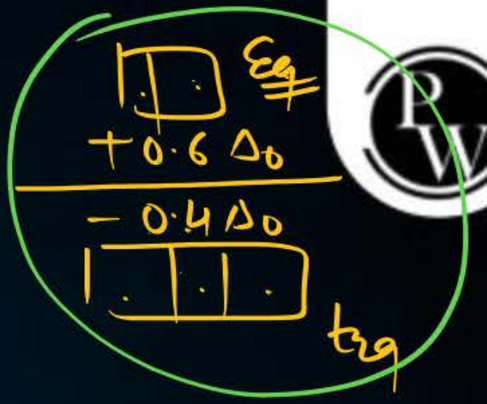
(B) $[Ni(H_2O)_2(en)_2]^{2+}$ (ii) Green

(C) $[Ni(en)_3]^{2+}$ (iii) Blue

Calculation of CFSE

Crystal Field Stabilization Energy.

$\Delta_0 > P$
$\Delta_0 < P$



For Octahedral

$$CFSE = n(-0.4\Delta_0) + m(+0.6\Delta_0) + xP$$

In case of W.L pairing energy is Always zero.

$\therefore x = 0$

$0 \times P = \text{Zero}$

- P → Pairing energy ✓
- n ⇒ No. of e^- in t_{2g} ✓
- m = No. of e^- in eg ✓
- Δ_0 = Splitting Energy ✓
- x → no. of New Pairs → Pairing due to influence of S.L

d^4 W.L $\longrightarrow$ $t_{2g}^3 e_g^1$

$3(-0.4\Delta_0) + 1(+0.6\Delta_0) + \underbrace{0 \times P}_{\text{zero}}$

$-1.2\Delta_0 + 0.6\Delta_0$

$\boxed{-0.6\Delta_0}$ ✓

d^4 S.L $\longrightarrow$ $\underline{t_{2g}^4 e_g^0}$

$4(-0.4\Delta_0) + \overbrace{0(+0.6\Delta_0)}^{\text{zero}} + 1 \times P$

$\boxed{-1.6\Delta_0 + 1P}$ ✓

Zero CFSE

W.L d^5 $t_{2g}^3 e_g^2$ $3(-0.4\Delta_0) + 2(0.6\Delta_0)$

$-1.2\Delta_0 + 1.2\Delta_0$ zero

S.L/W.L d^{10} $t_{2g}^6 e_g^4$

$6(-0.4\Delta_0) + 4(0.6\Delta_0)$

$-2.40\Delta_0 + 2.40\Delta_0$

zero

Ex

$[Fe(H_2O)_6]^{3+}$ — $Fe^{3+} \rightarrow d^5$

$[Mn(H_2O)_6]^{2+}$ — Mn^{2+} d^5

d^5 in WFL

$t_{2g}^3 \, e_g^2$

Zero CFSE

OMC (Organometallic Compounds)

when Carbon is directly attached to Metal.

M – C

(M $\overset{\sigma}{-}$ C)

σ Bonded

Imp Ex.

- $RMgX$ grignard Reagent
- R_2Zn Frankland Reagent
- R_2CuLi gilman Reagent
- $(C_2H_5)_4Pb$ Tetra ethyl lead (T.E.L)
- $TiCl_4 + R_3Al$ or $TiCl_3 + R_2AlCl$ – Ziegler natta Catalysts.

π Bonded (πe^- donor ligands)

(M $\overset{\pi}{=}$ C)

- Ferrocene
- Cobaltocene
- Ruthenocene
- Zeise's Salt.

$K[PtCl_3(C_2H_4)]$

σ + π Bonded

M $\overset{\sigma}{-}$ C

(π)

Ex: "Metal Carbonyls"

Ex: $Fe(CO)_5$

$Ni(CO)_4$

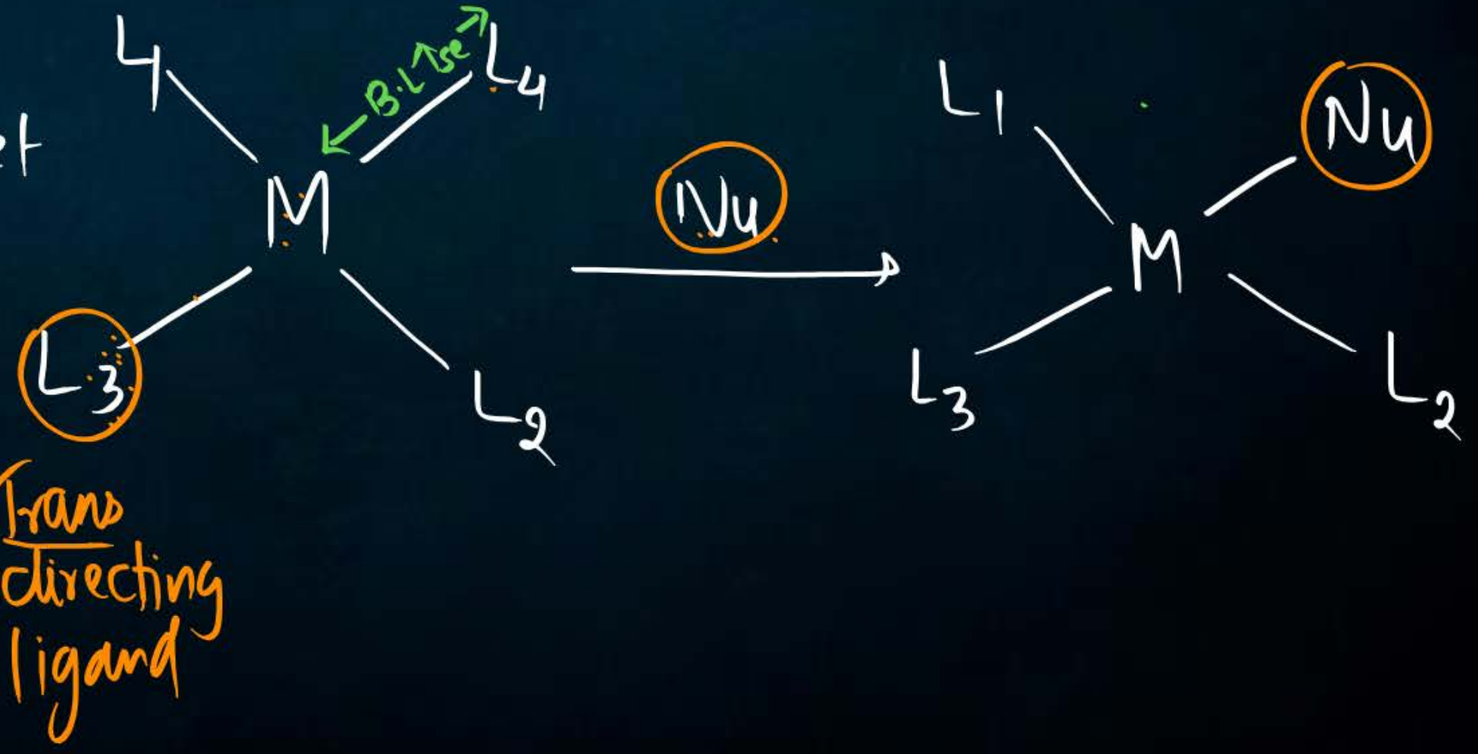
Trans Effect.

(occurs due to trans directing ligands)

Trans influence → Thermodynamic effect

Trans effect / Kinetic effect → True effect

Some ligands preferentially direct substitution trans to themselves.



Rough order of trans-directing effect :-
(In gen.)

$NO^+, CO, CN^-, C_2H_4 > PR_3, H^- > Me^- > Ph^- > NO_2^- > I^- > Br^-$

$> Cl^- > NH_3, OH^-, H_2O$

Q Correct increasing order of trans effect of the following species:-

NEET 2016

$$CN^- > C_6H_5^- > Br^- > NH_3$$

Jahn Teller effect.

Strong
Asymmetrical
eg Confi

Weak
Asymmetrical
t_{2g} Configur

* distortion in geometry
* Mainly observed in octahedral complexes.
* distortion due to Asymmetrical $\bar{e}$ configurations

d^0,
d^3 (W.L/S.L)
d^5 (W.L)
d^6 (S.L)
d^8
d^{10} } (S.L/W.L)

– Symmetric $\bar{e}$ Configuration.

Jahn Teller effect not observed.

Homework

From Module

All questions except Isomeresm & Uses

Ex. 1 Q 50 to 79

Q 108 - 140

Ex. 3 Q 1 - 10

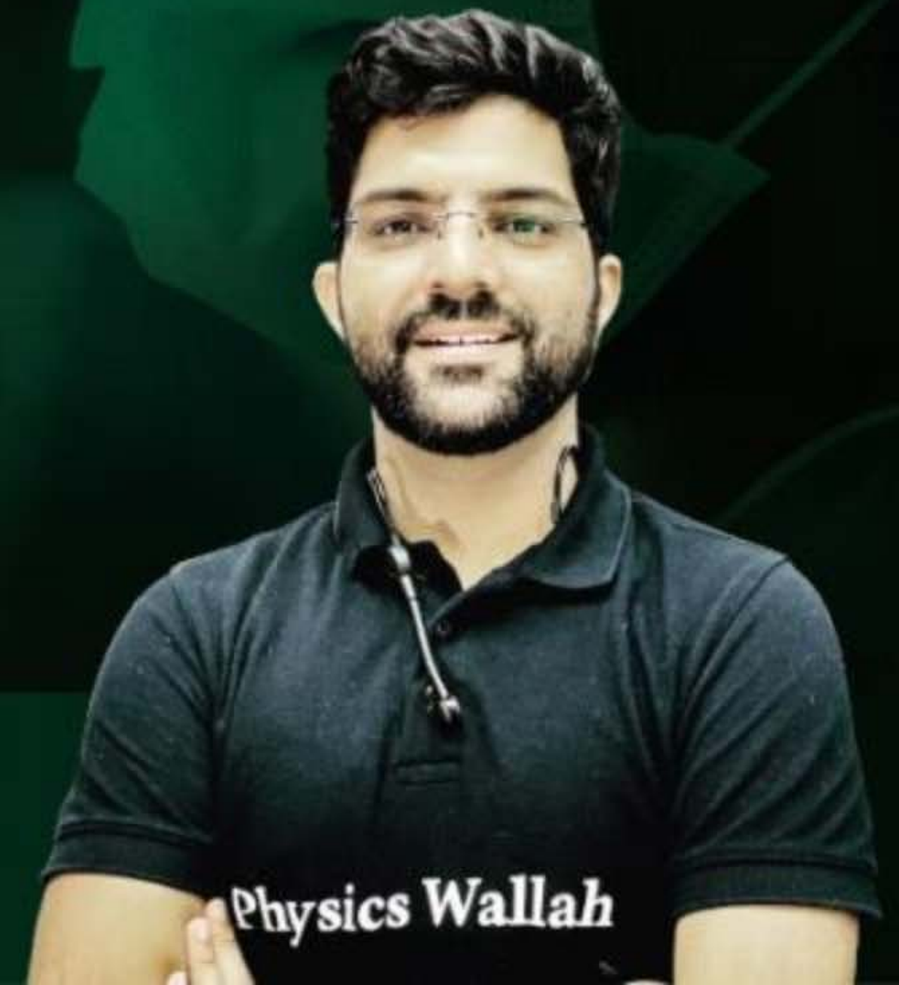
THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture - 10 | Inorganic Chemistry

Coordination Compounds



By - Mohit Dadheech (MD Sir)

Topics *to be covered*

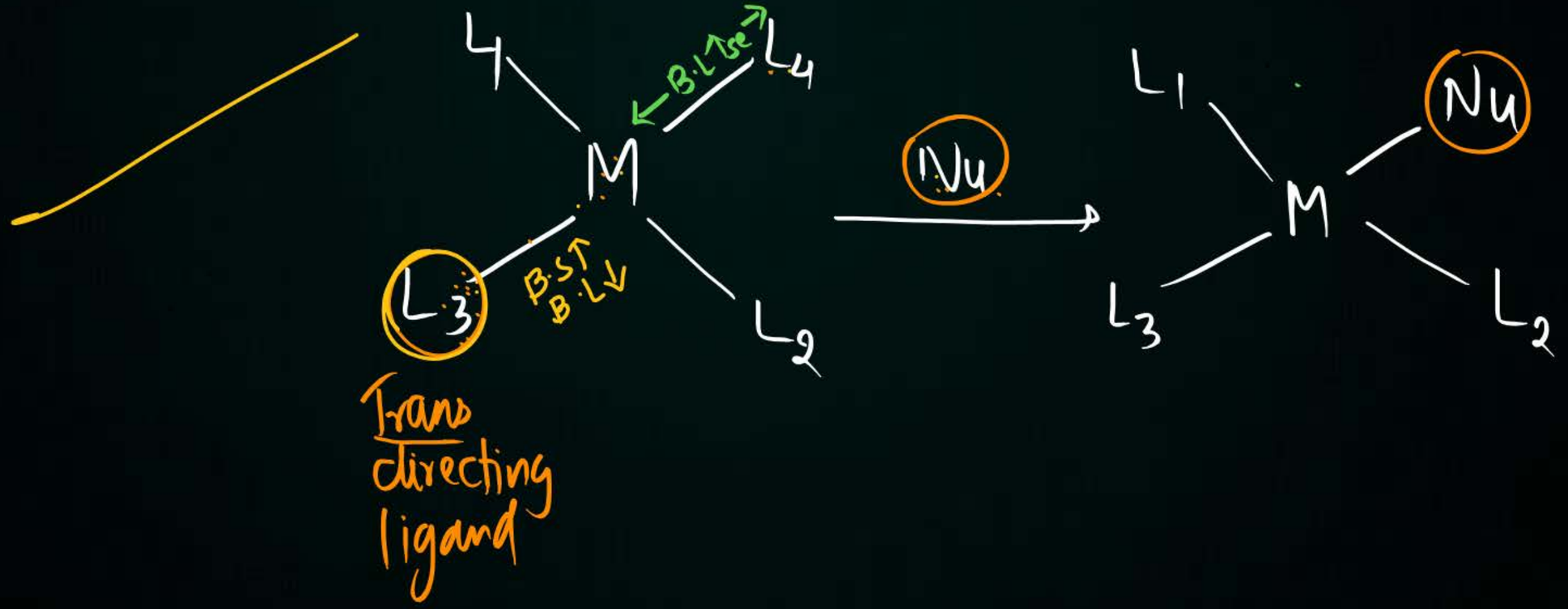
1. Isomerism in Complexes.
2.

Trans Effect.

(occurs due to trans directing ligands)

Some ligands preferentially direct

Substitution trans to themselves.



Rough order of trans-directing effect :-
(In gen.)

$NO^+, CO, CN^-, C_2H_4 > PR_3, H^- > Me^- > Ph^- > NO_2^- > I^- > Br^-$

$> Cl^- > NH_3, OH^-, H_2O$

Q Correct increasing order of trans effect of the following species:-

NEET 2016

$$CN^- > C_6H_5^- > Br^- > NH_3$$

Jahn Teller effect

- Strong: Asymmetrical e_g Confi
- Weak: Asymmetrical t_{2g} Configur

* distortion in geometry ✓
* Mainly observed in octahedral complexes.
* distortion due to Asymmetrical $\bar{e}$ Configurations

d^0,
d^3 (W.L/S.L)
d^5 (W.L)
d^6 (S.L)
d^8
d^{10} } (S.L/W.L)

– Symmetric $\bar{e}$ Configuration.

Jahn Teller effect not observed.

Isomerism in coordination compound

(1) Structural isomerism

i. Ionization
ii. Linkage isomerism
iii. Hydrate isomerism
iv. Coordination isomerism

Molecular Formula Same

(2) Stereo isomerism

i. Geometrical
ii. Optical

Structural isomerism

Ionization Isomerism - Isomers which produce different ions on ionization. This form of isomerism arises when the counter ion in a complex salt is itself a potential ligand and can displace a ligand.

Can be differentiated by Conductivity, Precipitation Measurements.

Ex. :

$[Pt(NH_3)_3Cl]Br \xrightarrow{AgNO_3}$ AgBr↓ Pale yellow

$[Pt(NH_3)_3Br]Cl \xrightarrow{AgNO_3}$ AgCl↓ White

$[Co(NH_3)_5SO_4]Br \xrightarrow{AgNO_3}$ AgBr↓ Pale yellow

$[Co(NH_3)_5Br]SO_4 \xrightarrow{BaCl_2}$ $BaSO_4$↓ White ppt.

Linkage isomerism - isomerism arises due to presence of AMBIDENTATE ligands.

Same Molecular Formula but diff Metal-ligand linkages

Ex. : $[Pt(NH_3)_5NO_2]Cl_2$ $[Pt(en)SCN(NO_2)]$

$[Pt(NH_3)_5ONO]Cl_2$

$l^1 = (2)$

SCN ONO
NCS NO_2
NCS ONO
$= (4)$

$n=2$ $l^2=4$

#MDI

No. of linkage isomerism

L.I = l^n

n = no. of Ambidental

Solvate isomerism - Known as hydrate isomerism when solvent is water. Occurs to difference in no of H_2O present in coordination sphere.

Same Molecular Formula but diff no. of water of Crystallisation

* differentiated by Precipitation, Conductance & by suitable dehydrating agent (gen. $Conc. H_2SO_4$)

Ex $CrCl_3 \cdot 6H_2O$

$[Cr(H_2O)_6]Cl_3$

$[Cr(H_2O)_5Cl]Cl_2 \cdot H_2O$

$[Cr(H_2O)_4Cl_2]Cl \cdot 2H_2O$

$[Cr(H_2O)_3Cl_3]^0 \cdot 3H_2O$

		AgCl ppt on Rxn with $AgNO_3$	no. of ions
(A)	$[Cr(H_2O)_6]Cl_3$	3 AgCl↓	4
(B)	$[Cr(H_2O)_5Cl]Cl_2 \cdot H_2O$	2 AgCl↓	3
(C)	$[Cr(H_2O)_4Cl_2]Cl \cdot 2H_2O$	1 AgCl↓	2

($C \cdot H_2SO_4$)
dehydrating agent can absorb crystalline water

$A < B < C$

Coordination Isomerism

$[ML_n]^+$ $[ML_n]^-$

* occurs when Cation & anion Present as Coordination entity

* Same Molecular Formula but different Coordenation Spheres due to Exchange of ligands

#MDJ Case-I when monodentate ligands are present

- Same M: $C.I = \frac{C.N.}{2}$
- diff' M: $C.I. = C.N.$

Ex $[Co(NH_3)_6]^{3+}$ $[Cr(NO_2)_6]^{3-}$

Metal diff C.N. = 6

C.I = ⑥ ≠

Ex $[Fe(NH_3)_6]^{3+}$ $[Fe(NH_2)_6]^{3-}$

Metal same

C.N. = 6

C.I = $6/2$ = ③

Case-II MDJ

When bidentate ligands are present.

- Same M: $C.I. = \left(\frac{C.N.}{2}\right) - 1$
- diff M: $C.I. = \left(\frac{C.N.}{2}\right) + 1$

$[Cr(en)_3]^{3+}$ $[Co(CN)_6]^{3-}$

diff 'M'

$C.N. = 6$

$C.I. = \left(\frac{6}{2}\right) + 1 = 4$

$[Co(en)_3]^{3+}$ $[Co(CN)_6]^{3-}$

Metal Same.

$C.N. = 6$

$C.I. = \left(\frac{6}{2}\right) - 1 = 2$

$[Co(en)_3]^{3+}$ $[Co(CN)_6]^{3-}$

Same

$[Co(en)_2(CN)_2]$ $[Co(en)CN_4]$

$[Co(en)CN_4]$ $[Co(en)_2CN_2]$

Same

$[Co(CN)_6]$ $[Co(en)_3]$

M → Same.

$C.I. = \left(\frac{6}{2}\right) - 1 = 2$

Coordination Isomerism

Home work

$[Pt[(NH_3)_4]\ [PtCl_4]$

$[Co(NH_3)_6]\ [Cr(CN)_6]$

Stereoisomerism

Same chemical formula & same chemical bonds but different spatial arrangements.

Two Types - (1) Geometrical isomerism (cis-trans)

(2) Optical isomerism (mirror image isomerism)

G.I → ~~Tetra~~ octa, sq. planar.

O.I → tetra, octa, ~~sq. planar~~ ∵ pos. ✗

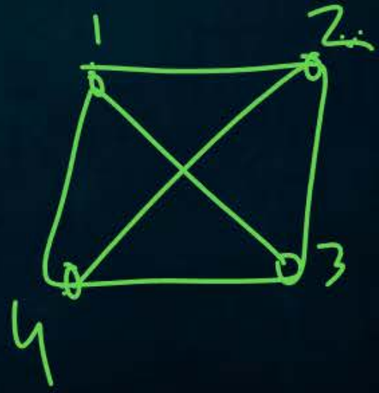
Geometrical Isomerism

NOTE

Tetrahedral Complexes do not show Geometrical Isomerism.

cis (90°) → two identical ligands adjacent to each other.

trans (180°) two identical ligands opposite to each other.



1, 2.
2, 3
.3, 4
4, 1
} cis

trans 1, 3,
2, 4

G.I in Complexes having Coordination no = 4

① ~~Tetra~~ No. G.I

② Sq. planar

G.I in Sq. planar Complexes

~~O/I~~

Cis: 1, 2
2, 3
3, 4
4, 1

Trans: 1, 3
2, 4

G.I ~~O.I~~

① When All monodentate ligands are present

Ma_4 ⟶ NO G.I

Ma_3b or Mab_3 → No G.I

Ma_2b_2 ⟶ 2 G.I

Ma_2bc ⟶ 2 G.I

$Mabcd$ ⟶ 3 G.I

(ab) (cd)
(ac) (bd)
(ad) (bc)
} 3 G.I

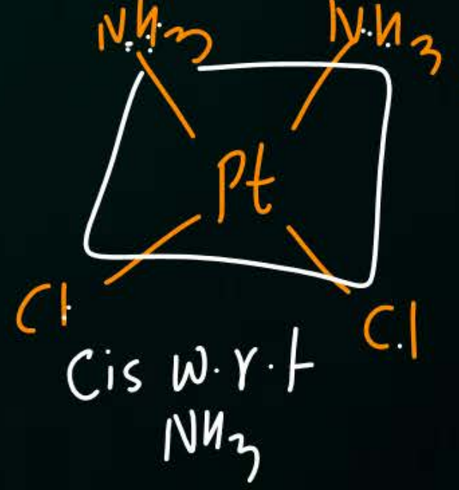
a, b, c, d, e, f ... → Monodentate ligands

(AA) → Symmetrical bidentate. en, ox

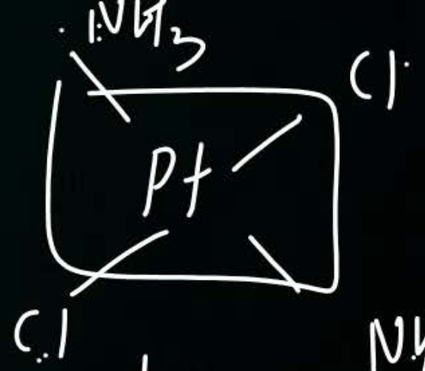
(AB) → Unsymmetrical bidentate gly.

Ex $[Pt(NH_3)_2Cl_2]$

Ma_2b_2



Cis w.r.t NH_3



trans w.r.t NH_3

(2) When bidentate ligands are present :-

#MDJ if (AA) present → G.I Always Zero.

(1) $M(AA)_2$

(2) $M(AA)b_2$

(3) $M(AA)bc$

} - NO G.I

Ex.

(4) $M(AB)_2$ $[Pt(gly)_2]$ 2 G.I

(5) $M(AB)b_2$ No G.I

(6) $M(AB)bc$ 2 G.I

#MDJ

Zn, Cd, Hg Complexes C.N = 4 Always tetra

($\because$ d^{10}.) ~~dsp^2~~ sp^3 ✓

Pt, Pd, Complexes having C.N. 4 = Sq. planar.

4d/5d all ligands (S.L) ✓

d^8 dsp^2 ✓

Pairing ✓

Tetrahedral Complex

tetrahedral complexes are optically active when :-

(i) M^{*}_{abcd}

(ii) $M(AB)_2$

(iii) $M(AB)bc$

Ma_4
Ma_3b
Ma_2b_2
Ma_2bc
$M(AA)_2$
$M(AA)b_2$
$M(AA)bc$
$M(AB)b_2$

No Isomerism

Homework

G.I / O.I

C.N = 4

SP $[Pt(NH_3)_4]$ Ma_4 — O.I ✗, G.I ✗

SP $[Pt(NH_3)_3Cl]$ Ma_3b — NO. O.I, NO. G.I

SP $[Pt(en)Cl_2]$ $M(AA)b_2$ — O.I ✗, G.I ✗

SP $[Pd(en)BrCl]$ $M(AA)bc$ — O.I ✗, G.I ✗

SP $[Pt(NH_3)(PH_3)BrCl]$ — O.I ✗

$Mabcd$ G.I = 3

SP $[Pt(gly)_2]$ $M(AB)_2$ — O.I ✗, G.I = 2

SP $[Ni(dmg)_2]$ $M(AA)_2$ — O.I ✗, G.I ✗

Tetra $[Zn(NH_3)_4]^{2+}$ Ma_4 — NO O.I, NO G.I

Tetra $[Zn(NH_3)_2Cl_2]$ Ma_2b_2 — G.I ✗, O.A ✗

Tetra $[Cd(NH_3)(PH_3)Cl.Br]$ $M^{*}abcd$

O.I ✓

NO. G.I

$[NiCl_4]^{2-}$ sp^3 May

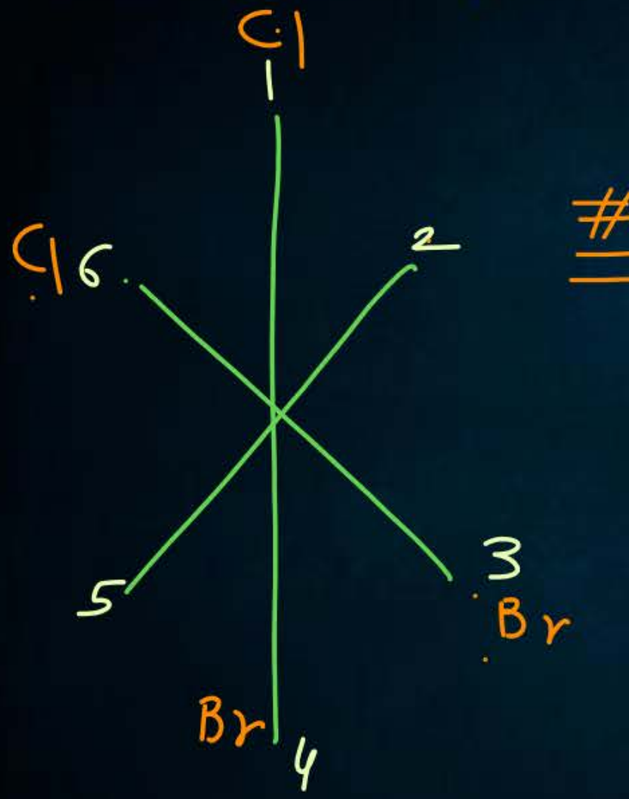
$[Ni(CN)_4]^{2-}$ dsp^2 May

$[PtCl_4]^{2-}$ dsp^2 May

$[PdCl_4]^{2-}$ dsp^2 May

→ NO G.I
NO O.I

Octahedral complex



Trans → (1,4) (6,3) (2,5)

Some Gen Rules

#MDJ

(1) if two same ligands are present at any one trans position then complex will be optically Inactive

(2) if any two trans positions are mutually same then Complex will be optically Inactive.

(3) if non Co-planar rings are present then Complex will be optically Active

(1). Ma_6

(aa) (aa) (aa)

No G.I

No. O.I

Ex $[Ni(NH_3)_6]^{2+}$

$[Fe(CN)_6]^{4-}$ etc.

(2) Ma_5b

(aa) (aa) (ab)

No G.I

No O.I.

Ex $[Co(NH_3)_5Cl]^{2+}$ etc.

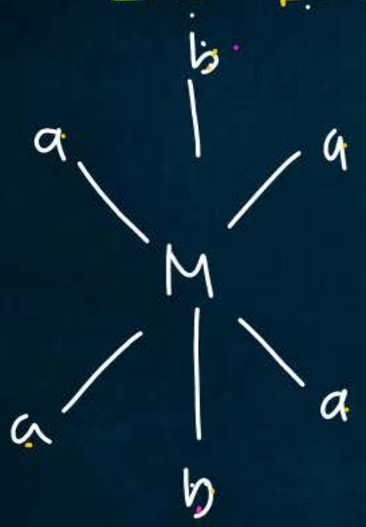
③ Ma_4b_2

(aa) (aa) (bb)

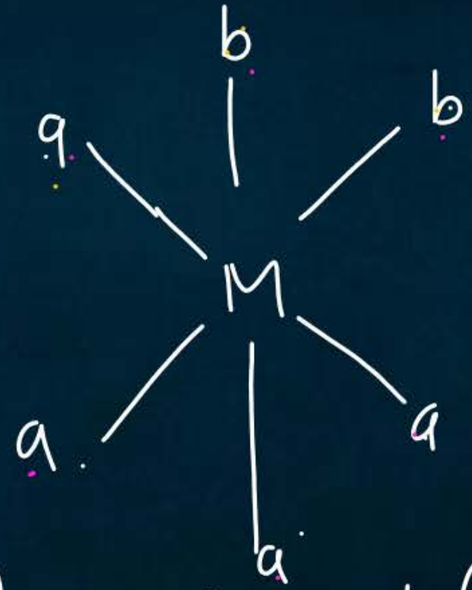
(aa) (ab) (ab)

NO. O.I

G.I = 2



trans w.r.t (bb)



cis w.r.t (bb)

Ex $[Pt(NH_3)_4Cl_2]^{2+}$

Ma_4b_2

$[Co(NH_3)_4Cl_2]^{+}$

a b

④ $M_{a_4}bc$ (aa)(aa)(bc) NO O.I

(aa)(ab)(ac) 2 G.I (Both are Inactive)

Ex $[Co(NH_3)_4 Br Cl]^+$ etc.

trans w.r.t (bc)

cis w.r.t (bc)

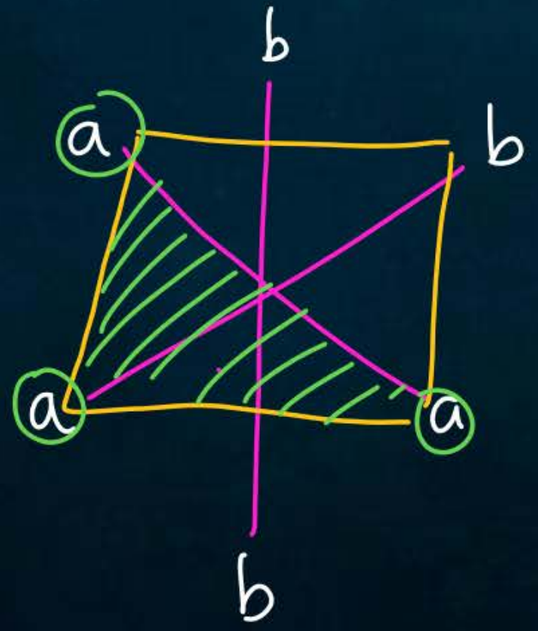
⑤ Ma_3b_3

(aa) (ab) (bb) Mer

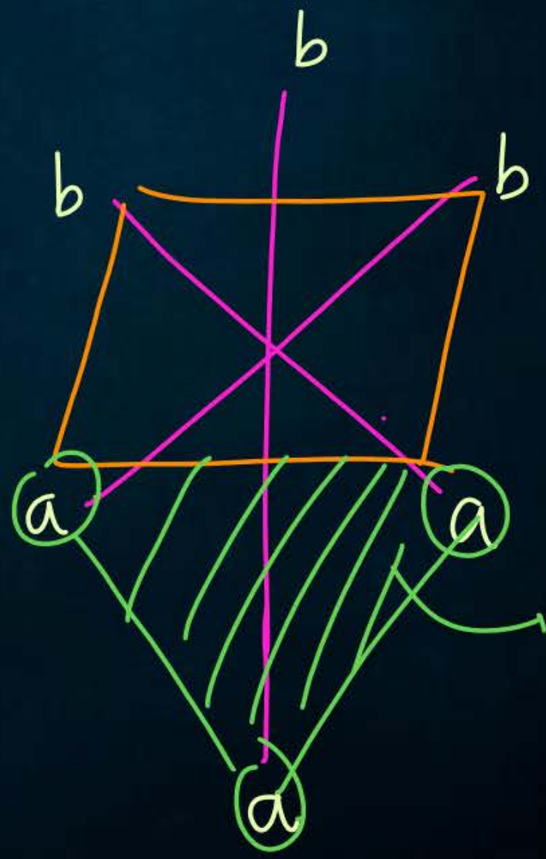
2 G.I Both are optically Inactive

(ab) (ab) (ab) Fac

O.I



Mer (Meridional)



Facial

(Fac)

Case	No. of G.I	optically active pairs	S.T
Ma_6	0	0	0
Ma_5b	0	0	0
Ma_4b_2	2	0	2
Ma_4bc	2	0	2
Ma_3b_3	2	0	2
Ma_3b_2c	3	0	3
Ma_3bcd	4	1	5
$Ma_2b_2c_2$	5	1	6
Ma_2b_2cd	6	2	8
Ma_2bcde	9	6	15
$Mabcdef$	15	15	30

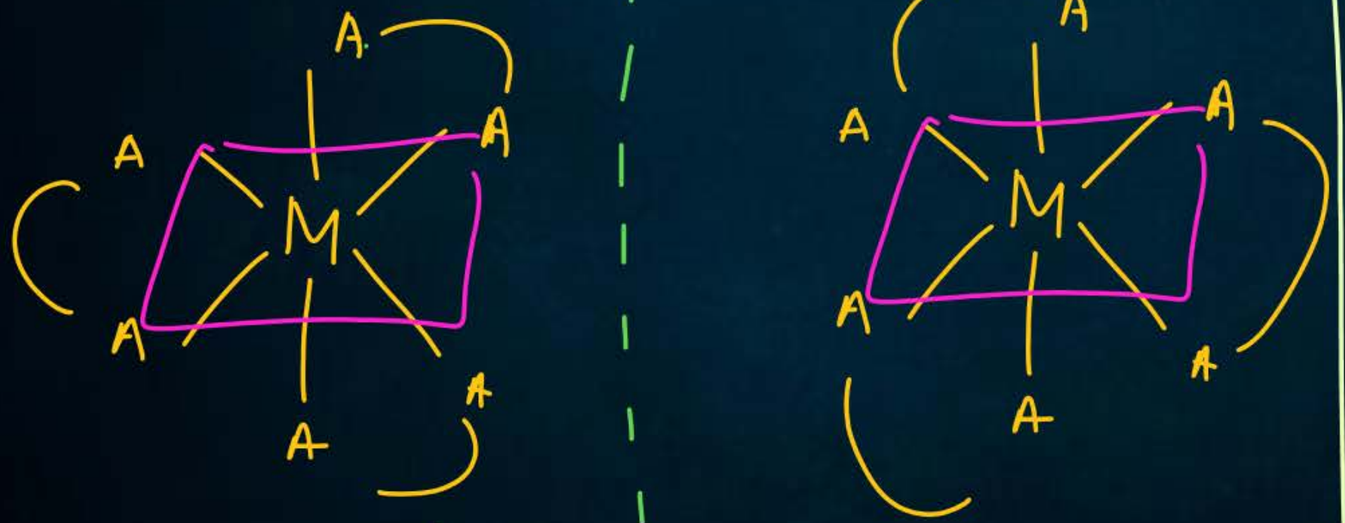
INSERT

0 0 2 2 2 3 4 5 6 9 15

V. Imp When Bidentate ligands are present :-

(1) $M(AA)_3$ → NO. G-I

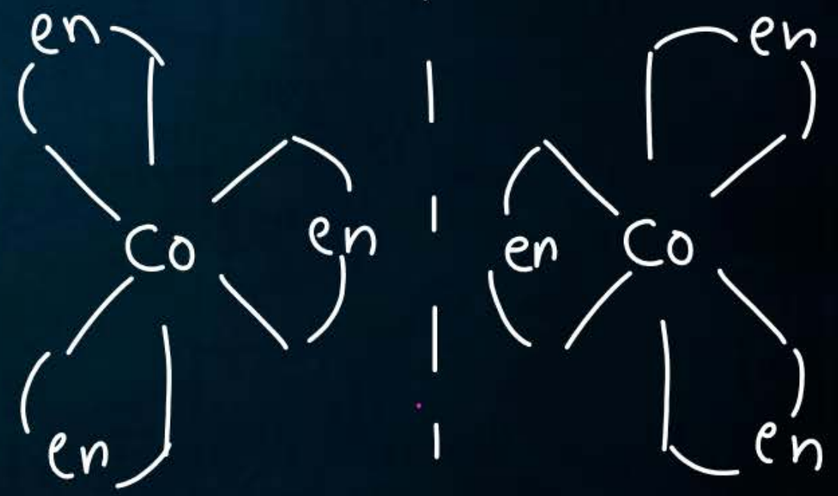
S.I = (2)



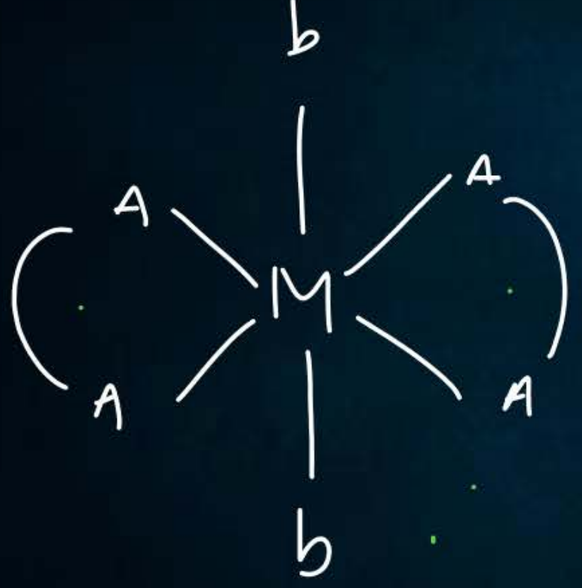
Non-coplanar Rings ✓

optically active

Ex $[Co(en)_3]Cl_3$

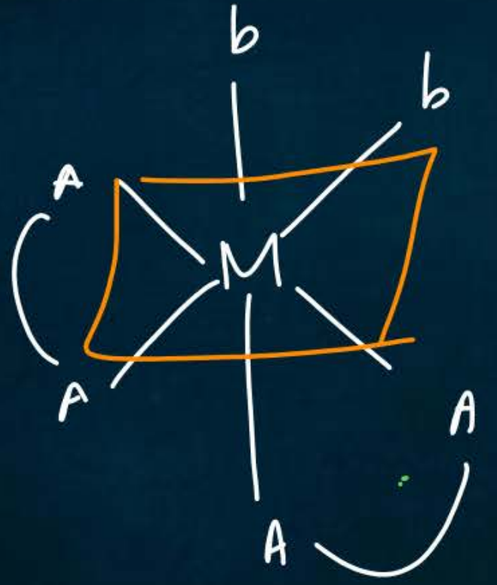


② $M(AA)_2b_2$ → G.I = 2, Cis is active, S.I = 3



trans w.r.t (bb)

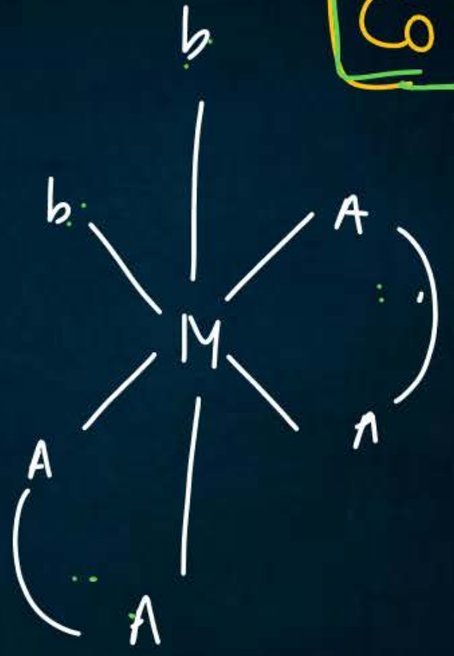
Inactive



Non coplanar rings ⇒ Active

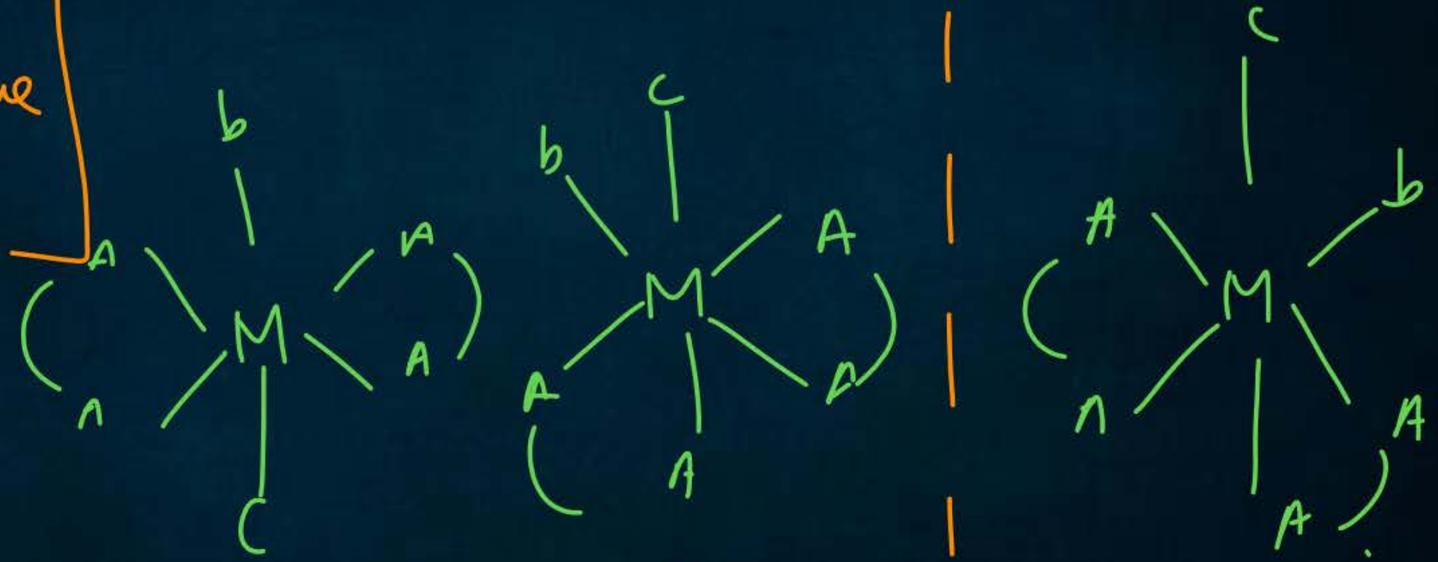
Cis w.r.t bb

Ex $[Co(en)_2Cl_2]Cl$



③ $M(AA)_2bc$ Same as pre. Ex.

[2 G.I
Cis active
S.I = 3]



trans w.r.t (bc)
Inactive

cis
w.r.t (bc)
Active

QUESTION

$[Ma_4b_2]$ G.I

$[Co(NH_3)_4(NO_2)_2]Cl$ exhibits : [AIPMT 2006]

NO_2^- Ambi.

1. Linkage isomerism, geometrical isomerism and optical isomerism

2. Linkage isomerism, ionization isomerism and optical isomerism

3. Linkage isomerism, ionization isomerism and geometrical isomerism

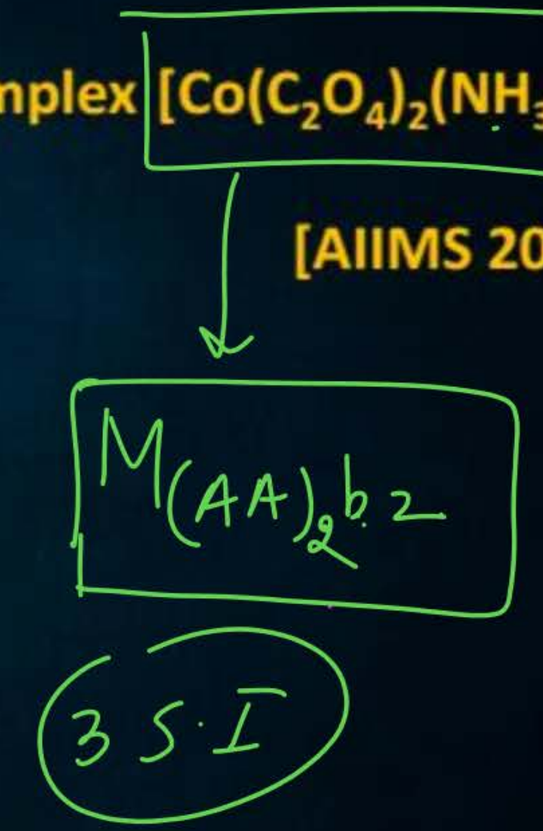
4. Ionization isomerism, geometrical isomerism and optical isomerism

QUESTION

The number of possible isomers of an octahedral complex $[Co(C_2O_4)_2(NH_3)_2]^-$ is :

[AIIMS 2006]

1. 1
2. 2
3. 3
4. 4



QUESTION

Which of the following will give a pair of enantiomorphs :

[AIPMT 2007]

1. $[Cr(NH_3)_6]\,[Co(CN)_6]$

2. $[Co(en)_2Cl_2]Cl$

3. $[Pt(NH_3)_4]\,[PtCl_6]$

4. $[Co(NH_3)_4Cl_2]\,NO_2$

QUESTION

Which of the following does not show optical isomerism ?

[AIPMT 2009]

1. $[Co(en)_3]^{3+}$ $M(AA)_3$ ✓ O.I

2. $[Co(en)_2Cl_2]^{+}$ $M(aa)_2b_2$ ✓ O.I

3. $[Co(en)_2ClBr]^{+}$ $M(aa)_2bc$ ✓ O.I

4. $[Co(NH_3)_4Cl_2]NO_2$ Ma_4b_2 ✗

QUESTION

Which one of the following complexes is not expected to exhibit isomerism:

[AIPMT 2009]

1. $[Pt(NH_3)_2Cl_2]$ Ma_2b_2 sp G.I ✓
2. $[NiCl_4]^{2-}$ Ma_4 sp^3 tetra. ✓
3. $[Ni(en)_3]^{2+}$ $M(AA)_3$
4. $[Ni(NH_3)_4(H_2O)_2]^{2+}$ Ma_4b_2.

QUESTION

The existence of two different coloured complexes with the composition of $[Co(NH_3)_4Cl_2]^+$ is due to : [AIPMT 2010]

1. Ionization isomerism

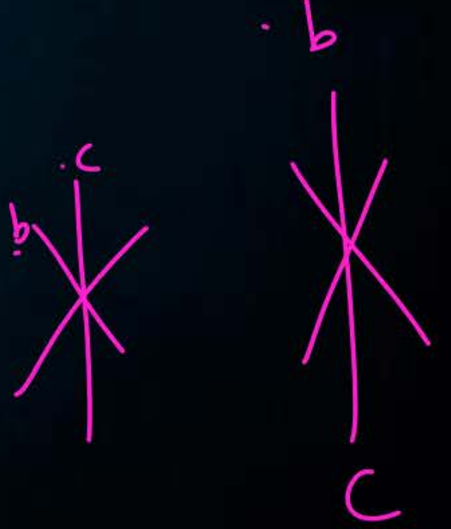
2. Linkage isomerism

3. Geometrical isomerism

4. Coordination isomerism

$[Ma_4b_2]^+$

G.I
- Cis
- Trans



QUESTION

The complex $[Co(NH_3)_6]$ $[Cr(CN)_6]$ and $[Cr(NH_3)_6]$ $[Co(CN)_6]$ are the examples of which type of isomerism ?

[AIPMT Pre. 2011]

1. Linkage isomerism
2. Ionization isomerism
3. Coordination isomerism
4. Geometrical isomerism

QUESTION

The complex [Pt(Py)(NH_3)BrCl] will have how many geometrical isomers ?

[AIPMT Pre. 2011]

Mabcd

sq. Plan

G.I = 3

1. 3
2. 4
3. 0
4. 2

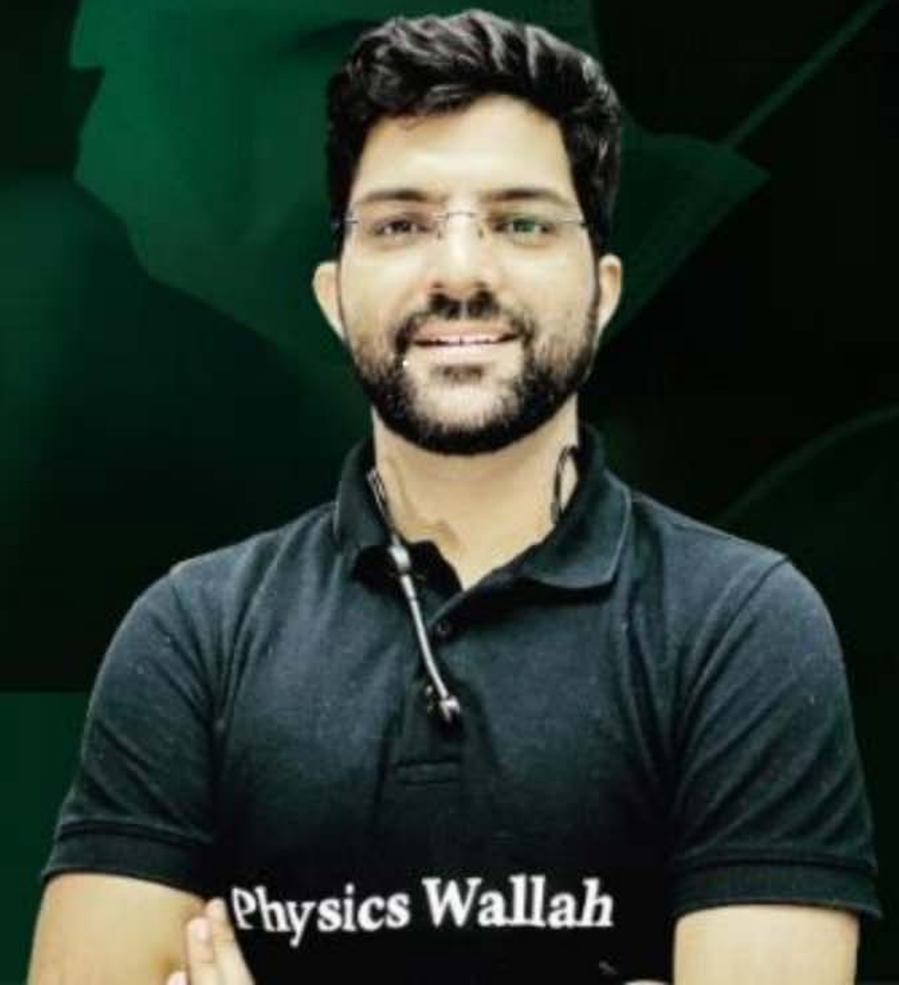
THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture - 11 | Inorganic Chemistry

Coordination Compounds



By - Mohit Dadheech (MD Sir)

Topics *to be covered*

1. Imp. Applications & Questions.

Importance & Applications of Coordination Compounds

Fe^{3+} $[Fe(CN)_6]^{4-}$ → $Fe_4[Fe(CN)_6]_3$

(1) $K_4[Fe(CN)_6]$

* Imp. Lab. Reagent
* Used in test of Fe^{3+}, Cu^{2+}, Zn^{2+} of

Fe^{3+} → Ferri
Fe^{2+} → Ferro

* Test of Fe^{3+} by Fe^{2+}

$K_4[Fe(CN)_6]$ (O.N = +2)

Fe^{3+} → $Fe_4[Fe(CN)_6]_3$ Prussian Blue
Ferri Ferrocyanide
Iron(III) Hexacyanidoferrate(II)

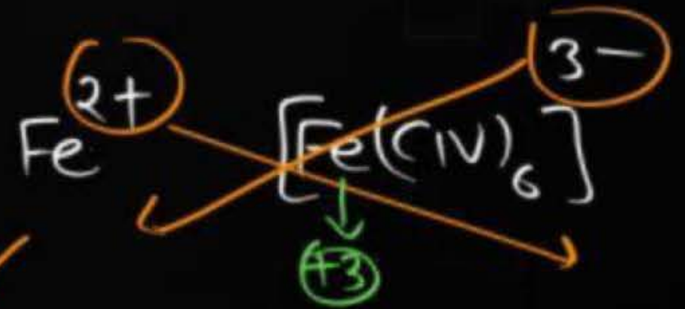
Cu^{2+} → $Cu_2[Fe(CN)_6]$ chocolate Brown ppt
Used in Formation of artificial semipermeable membrane

Zn^{2+} → $Zn_2[Fe(CN)_6]$
Blue-white ppt.

(2) $K_3[Fe(CN)_6]$

O.N. = (+3)

* Lab reagent
* Used in test of Fe^{2+}
* Test of Fe^{2+} by Fe^{3+}



$$K_3[Fe(CN)_6] \xrightarrow{Fe^{2+}} Fe_3[Fe(CN)_6]_2$$

Ferro Ferri cyanide

Turnbull's Blue

MDT Tu_4 (Q) vala Fe^{2+} se start Nota Hai

Iron(II) Hexacyanido ferrate(III)

(3) $K_3[Cu(CN)_4]$ ⇒ Formed during test of Cu^{2+} ions.

Imp

$Cu^{2+} \xrightarrow{KCN\ (R.A)} Cu^{+} \xrightarrow[\text{Excess}]{KCN} K_3[Cu(CN)_4] \xrightarrow{H_2S}$ No Reaction.

(CN^-)

(Complexing agent)

CN^- (ligand)

↳ Stable Complex

(4) $K_2[Cd(CN)_4]$

* Formed during test of Cd^{2+}

$Cd^{2+} \xrightarrow[\text{Excess}]{KCN} K_2[Cd(CN)_4] \xrightarrow{H_2S} CdS\downarrow$ yellow ppt

↓

Unstable Complex

$K_3[Cu^{+1}(CN)_4] > K_2[Cd^{+2}(CN)_4]$

⑤ $K_2[HgI_4] + KOH$

Imp

↓

Nessler's Reagent

* Use → test of NH_4^+ (zero group cation)

$$NH_4^+ + KOH \longrightarrow (NH_3\uparrow) + K_2[HgI_4]$$

↓

Brown ppt ⇒ $HgO \cdot Hg \begin{cases} NH_2 \\ I \end{cases}$

Iodide of Milons Base

$NH_4^+ + K_2[HgI_4] + KOH$

⇓

Brown ppt

V. Imp ⑥ $[Fe(H_2O)_5NO]SO_4$

* Brown Ring Complex.
* Formed during the test of NO_3^- (Nitrate) & NO_2^- (Nitrite) ions

test for NO_3^-

$$NO_3^- + \underset{(R.A)}{Fe^{+2}SO_4} \longrightarrow Fe_2^{+3}(SO_4)_3 + N^{+2}O$$

$$Fe^{+2}SO_{4(aq)} + NO \longrightarrow [Fe(H_2O)_5NO]SO_4$$

Freshly Prepared

BRC.

(7) V. Imp $Na_2[Fe(CN)_5NO]$ Sodium Nitroprusside (SNP)

* Lab Reagent
* Used in the test of S^{2-} (sulphide)

$$Na_2[Fe(CN)_5NO] \xrightarrow{S^{2-}} Na_4[Fe(CN)_5NOS]$$

Red Brown
(SNP)

Purple / Violet
(STNP)

Sodium thionitroprusside

⑧ $Ni(CO)_4$

* sp^3, tetrahedral
* $\pi + \sigma$ OMC
* Synergic Bonding
* diamagnetic Complex
* Formed during the purification Process of "Ni" (Mond's Process)

Impure Ni $\xrightarrow[\text{(Reagent)}]{CO}$ $Ni(CO)_4$ $\xrightarrow{\Delta}$ Ni (Pure)

Volatile Complex

(9) $[Pb(edta)]^{2-}$ Formed during treatment of lead poisoning

$$[Ca(edta)]^{2-} \xrightarrow{Pb^{2+}} [Pb(edta)]^{2-} + Ca^{2+}$$

(Injection)

(10) $[Pt(NH_3)_2Cl_2]$ Sq planar complex having 2 G.I Cis & trans

"Cis" is used as anticancer drug (Cis platin)

(11) $[Cu(NH_3)_4]SO_4$ → deep Blue colour Complex

→ Formed by the Reaction of $CuSO_4$ & NH_3 (excess)

(12) $Na_3[Ag(S_2O_3)_2]$

* Formed during Photography Fixing.

When Undecomposed AgBr is dissolved into $Na_2S_2O_3$ (Hypo)

→ Undecomposed AgBr.

$AgBr \xrightarrow{h\nu} Ag$

$AgBr + Na_2S_2O_3 \longrightarrow Na_3[Ag(S_2O_3)_2]$

Sod. thiosulphate (Hypo)

(13) $Ni(dmg)_2$

H.W

NOTES

(14) $Na[Ag(CN)_2]$ & $Na[Au(CN)_2]$

* Formed during the Extraction of Ag & Au.
* Mac Aurther forestcyanide Process

$$Ag_2S + NaCN + H_2O + O_2 \xrightarrow[(OA)]{} Na[Ag(CN)_2]^{**} + Na_2SO_4$$

$$Na[Ag(CN)_2] \xrightarrow{Zn\,(RA)} {}^{*}Na_2[Zn(CN)_4] + Ag\downarrow$$

(15) Ferrocene $Fe(C_5H_5)_2$ π. Bonded OMC.

(16) Zeise's salt $K[Pt(Cl_3)C_2H_4]$

used as Anticancer drug

Question

The coordination number and oxidation number of the central metal ion in the complex $[Pt(en)_2]^{+2}$ is:

1. C. N. = 2,O. N. = +2
2. C. N. = 6,O. N. = +4
3. C. N. = 4,O. N. = +4
4. C. N. = 4,O. N. = +2

Question

Select bidentate or didentate ligand from the following.

1. CO
2. SCN^-
3. CH_3COO^-
4. $C_2O_4^{2-}$

Question

The oxidation and coordination number of Pt in $[Pt(C_2H_4)Cl_3]^-$ is respectively :

1. + 1, 3
2. + 2, 4
3. + 3, 6
4. + 2, 5

Question

Incorrect statement about DMG :

1. It is tetradentate ligand
2. Chelating ligand
3. Donor atom is Nitrogen
4. In gravimetric determination of Ni is used

Question

Which of the following complexes is not a chelate

1. bis (dimethylglyoximato) nickel(II)
2. Potassium ethylenediaminetetrathiocyanato chromate(III)
3. Tetrammine dichlorocobalt(III) nitrate
4. Trans–diglycinatoplatinum(II)

Question

Which of the following has least conductivity in aqueous solution.

1. $Co(NH_3)_4Cl_3$ $[Co(NH_3)_4Cl_2]Cl$ 2 ions
2. $Co(NH_3)_3Cl_3$ $[Co(NH_3)_3Cl_3] \Rightarrow$ 0 ions
3. $Co(NH_3)5Cl_3$ $[Co(NH_3)_5Cl]Cl_2$ 3 ions
4. $Co(NH_3)_6Cl_3$ $[Co(NH_3)_6]Cl_3$ 4 ions

Question

O.S = +2

If EAN of a central metal ion X^{+2} in a complex is 34 and atomic number of X is 28. The number of monodentet ligands present in complex are:-

1. 3
2. 4
3. 6
4. 2

EAN = Z − O.S + $\bar{e}$ gained by ligand.

? : (E)

$34 = 28 - 2 + E$

$E = 34 - 26 = (8)$

No. of $\bar{e} = 8$

Ligands = 8/2 = (4)

Question

O.N = +3

The effective atomic number of Cr (atomic no. 24) in $[Cr(NH_3)_6]Cl_3$ is

1. 35
2. 27
3. 33
4. 36

24 − 3 + 12

21 + 12 = 33

Question

Which gives only 25% mole of AgCl, when reacts with $AgNO_3$:

1. $PtCl_2.4NH_3$ $[Pt(NH_3)_4]Cl_2$
2. $PtCl_4.5NH_3$ $[Pt(NH_3)_5Cl]Cl_3$
3. $PtCl_4.4NH_3$ $[Pt(NH_3)_4Cl_2]Cl_2$
4. $PtCl_4.3NH_3$ $[Pt(NH_3)_3Cl_3]Cl$ ✓

$Pt^{2+} \Rightarrow C.N = 4$

$Pt^{+4} \Rightarrow C.N = 6$

1 AgCl ↓

25% Cl^- ion is ionisable

Question

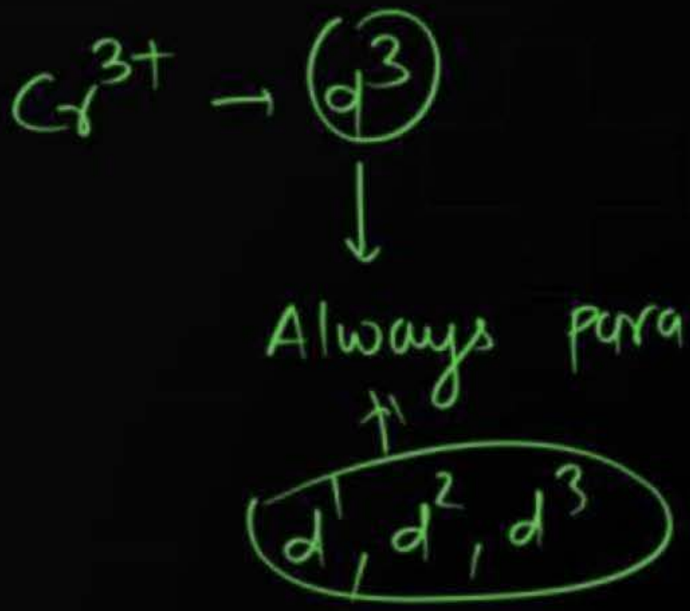
The shape of the complex $[Ag(NH_3)_2]^+$ is :

1. Octahedral
2. Square planar
3. Tetrahedral
4. Linear

Question

The magnetic property and the shape of $[Cr(NH_3)_6]^{3+}$ complex ions are :

1. Paramagnetic, Octahedral
2. Diamagnetic, square planar
3. Paramagnetic, tetrahedral
4. None of the above



Question

The wrong statement is : (gen. statements)

1. Halide ligands forms high spin complex ✓
2. Strong ligands form low spin complex ✓
3. $[FeF_6]^{-3}$ is inner orbital complex ✗
4. $[NiCl_4]^{-2}$ is outer orbital complex ✓

Question

In which of the following molecules, central atom used orbitals of different quantum number in the hybridisation :

1. $[Fe(CO)_5]$ dsp^3 → dsp^3, d^2sp^3
2. IF_7 sp^3d^3
3. $Ni(CO)_4$ sp^3
4. XeO_4 sp^3

Question

$Fe^{3+} \longrightarrow d^5$

w.L(F) $t_{2g}^3 e_g^2$ $n=5$ $\mu = 5....$

s.L(CN) $t_{2g}^5 e_g^0$ $n=1$ $\mu = 1....$

For $Fe(F)_6^{3-}$ and $Fe(CN)_6^{3-}$ magnetic moment of the fluoride complex is expected to be :-

1. The same as the magnetic moment of the cyanide complex
2. Larger than the magnetic moment of the cyanide complex because there are more unpaired electrons in the fluoride complex
3. Smaller than the magnetic moment of the cyanide compelx because there are more unpaired electrons in the fluoride complex
4. Larger than the magnetic moment of the cyanide complex because there are fewer unpaired electrons in the fluoride complex

Question

Which of the following complexes are low spin and diamagnetic?

(a) $K_4[Os(CN)_6]$ dia Low spin **(b)** $[Mo(CO)_6]$ dia Low spin

(c) $[Mn(CN)_6]^{4-}$ Para, Low spin.

Select the correct answer using the codes given below :

Cr
Mo
W

$4d^4\ 5s^2$

$4d^6$

Fe
Ru
Os $\rightarrow Os^{2+}$

$d^6 \xrightarrow{S.L} t_{2g}^6 e_g^0$ $n=0$

$d^6 \xrightarrow{S.L} t_{2g}^6 e_g^0$ $n=0$

M_n^{2+} $d^5 \xrightarrow{S.L} t_{2g}^5 e_g^0$ $n=1$

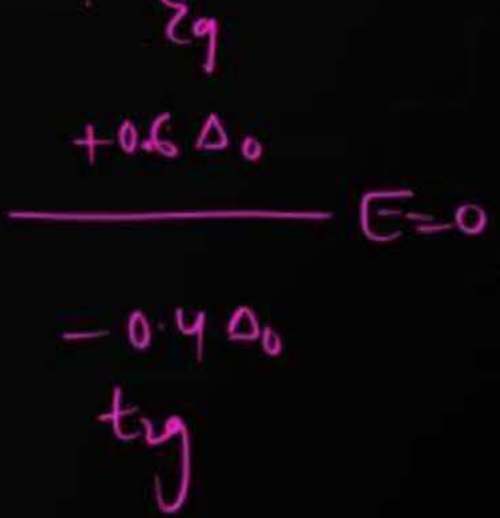
Para

1. a, b and c
2. a and b only
3. a and c only
4. b and c only

Question

In an octahedral crystal field, the t_{2g} orbitals are

1. Raised in energy by 0.4 Δ_0 w.r.t barycentre ✗
2. Lowered in energy by 0.4 Δ_0 w.r.t barycentre
3. Raised in energy by 0.6 Δ_0 w.r.t barycentre ✗
4. Lowered in energy by 0.6 Δ_0 w.r.t barycentre ✗



Question

If $\Delta_0 < P$, the correct electronic configuration for d^4 system will be :-

W.L

1. $t_{2g}^4 e_g^0$
2. $t_{2g}^3 e_g^1$
3. $t_{2g}^0 e_g^4$
4. $t_{2g}^2 e_g^2$

$d^4 \xrightarrow{W.L} t_{2g}^3 e_g^1$

Question

Select most stable complex :

1. $[Co(H_2O)_6]^{3+}$

2. $[Co(NH_3)_2(en)_2]^{+3}$

3. $[Co(en)_3]^{+3}$

4. $[Co(NH_3)_4(en)]^{+3}$

en > NH_3 > H_2O

Question

A square planar complex $[Pt(NH_3)_2Cl_2]$, shows :

Ma_2b_2 2 G.I

1. Geometrical isomerism
2. Optical isomerism ✗
3. Linkage isomerism ✗
4. None

Question

Which of the following complex produce ppt with $AgNO_3$ and exist in two geometrical isomeric form

1. $PtCl_2.4NH_3$ — $[Pt(NH_3)_4]Cl_2$, Ma_4
2. $PtCl_2.3NH_3$ — $[Pt(NH_3)_3Cl]Cl$, Ma_3b

} NO G.I

3. $PtCl_4.4NH_3$ — $[Pt(NH_3)_4Cl_2]Cl_2$, Ma_4b_2 ✓ G.I ✓ 2 AgCl ppt ✓
4. $PtCl_4.2NH_3$ — $[Pt(NH_3)_2Cl_4]$, Ma_2b_4 ✓ 2 G.I But No AgCl ppt

Ma_4b_2 / Ma_2b_4 } Same

2 G.I

Question

Cis$[Pt(en)_2Cl_2]Br_2.2H_2O$ and trans $[Pd(en)_2Br_2]Cl_2.2H_2O$ are :-

1. Ionisation isomer

Both are diff Complexes

2. Geometrical isomer ✗

3. Hydrate isomer

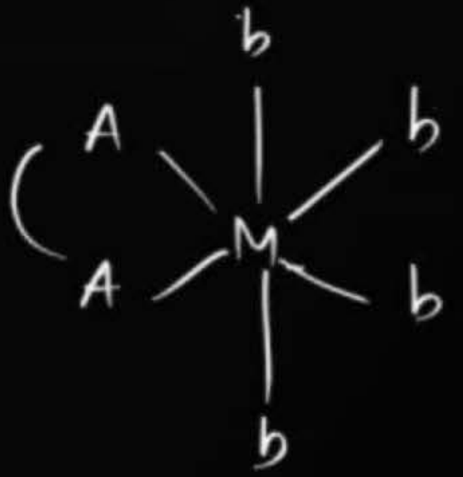
4. None of these ✓

Question

Which of the following octahydral complex have maximum stereoisomers :-

1. $[M(CN)_6]^{\pm}$ — Ma_6 → No. G.I, No. O.I

2. $[M(en)(CN)_4]^{\pm}$ — $M(AA)b_4$ → No. G.I, No. O.I



No. G.I / No. O.I

3. $[M(en)_2(CN)_2]^{\pm}$ — $M(AA)_2b_2$ → S.I = 3

4. $[M(en)_3]^{\pm}$ — $M(AA)_3$ → G.I, O.I

Question

Which of the following complex does no show geometrical isomerism?

1. $[Co(NH_3)_4Cl_2]^+$ Ma_4b_2 ✓
2. $[Co(NH_3)_3(NO_2)_3]$ Ma_3b_3 ✓
3. $[Cr(en)_3]^{3+}$ $M(AA)_3$ × G.I O.I
4. $[Pt(gly)_2]$ $M(AB)_2$ ✓ 2 G.I
   Sq. Planar

Question

Which of the following is π-acid ligand

1. NH_3
2. CO
3. gly.
4. ethylene diamine

Question

Synergic bonding involves :

1. The transference of electrons from ligands to metal
2. The transference of electrons from filled metal orbitals to anti-bonding orbitals of ligands
3. Both the above
4. None of these

Question

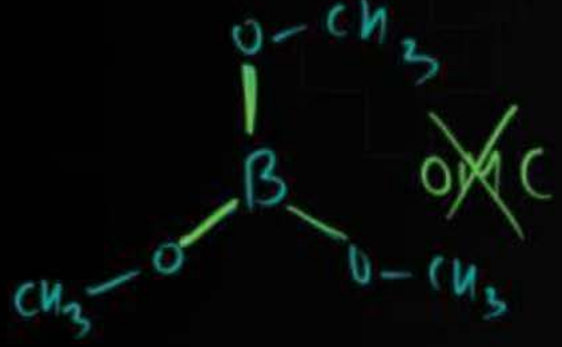
Which of the following is not an organometallic compound ?

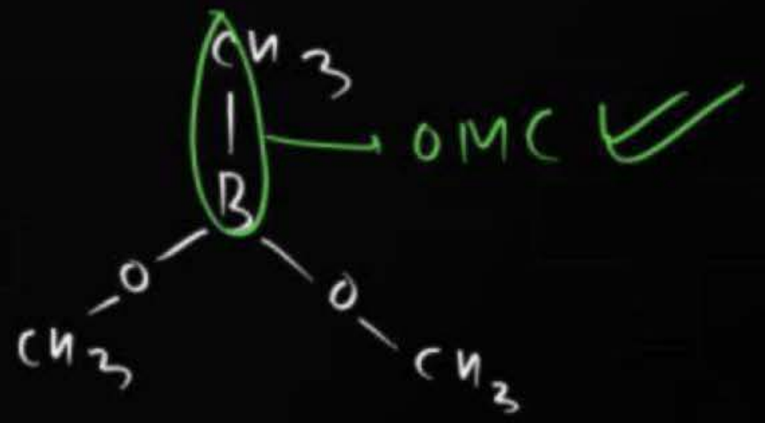
1. $(C_2H_5)_2Zn$

2. $CH_3B(OCH_3)_2$

3. $B(OCH_3)_3$

4. $Ni(CO)_4$





Question

In a ferric salt on adding KCN a prussian blue is obtained which is :

1. $K_3[Fe(CN)_6]$
2. $Fe_3[Fe(CN)_6]_4$
3. $FeSO_4[Fe(CN)_6]$
4. $Fe_4[Fe(CN)_6]_3$

Question

Which is correct :-

	Complex	No. of Rings	
1	$[Co(ox)_2Cl_2]^{-3}$	4	✗
2	$[Ni(dmg)_2]$	4	✓
3	$[Ca(EDTA)]^{-4}$	6	✗
4	Brown ring complex	1	✗

two 6M + two 5M

Question

Which of the following cannot show linkage isomerism?

1. NO_2^- ONO$^-$
2. SCN^- NCS$^-$
3. CN^- NC$^-$
4. NH_3

Question

Amongst $Ni(CO)_4$, $[Ni(CN)_4]^{2-}$ and $NiCl_4^{2-}$

1. $Ni(CO)_4$ and $NiCl_4^{2-}$ are diamagnetic and $[Ni(CN)_4]^{2-}$ is paramagnetic

H·W

2. $NiCl_4^{2-}$ and $[Ni(CN)_4]^{2-}$ are diamagnetic and $Ni(CO)_4$ is paramagnetic

3. $Ni(CO)_4$ and $[Ni(CN)_4]^{2-}$ are diamagnetic and $NiCl_4^{2-}$ is paramagnetic

4. $Ni(CO)_4$ is diamagnetic and, $NiCl_4^{2-}$ and $[Ni(CN)_4]^{2-}$ are paramagnetic

Question

Which of the following compounds is not coloured :

1. Na_2CuCl_4 d^9
2. Na_2CdCl_4 d^{10}
3. $K_4Fe(CN)_6$
4. $K_3Fe(CN)_6$

Question

Conc. H_2SO_4 will not dehydrate the following complex :

1. $[Cr(H_2O)_5Cl]Cl_2.H_2O$
2. $[Cr(H_2O)_4Cl_2]Cl.2H_2O$
3. $[Cr(H_2O)_6]Cl_3$
4. All of these

Question

$[Sc(H_2O)_6]^{3+}$ ion is :

1. Coloured and paramagnetic
2. Colourless and paramagnetic
3. Colourless and diamagnetic
4. Coloured and octahedral

Sc^{2+} d^1

Sc^{3+} d^0

diamagnetic.

$n=0$

Question

$PtCl_4$ 2KCl 3Cl⁻ ⇒ $2K[PtCl_3]^{3-}$

A co-ordination complex has the formula $PtCl_4.2KCl$. Electrical conductance measurements indicate the presence of three ion in one formula unit. Treatment with $AgNO_3$ produces no ppt. of AgCl. What is the co-ordination number of Pt in this complex :

1. 5
2. 6
3. 4
4. 3

$K_2[PtCl_6]$ Total ion = (3)

C.N = 6

Question

The colour of the coordination compounds depends on the crystal field splitting. What will be the correct order of absorption of wavelength of light in the visible region for the complexes, [NCERT EXEMPLAR]

$[Co(NH_3)_6]^{3+}$, $[Co(CN)_6]^{3-}$, $[Co(H_2O)_6]^{3+}$

$\Delta/\epsilon \propto \frac{1}{\lambda_{absorbed}}$

1. $[Co(CN)_6]^{3-} > [Co(NH_3)_6]^{3+} > [Co(H_2O)_6]^{3+}$
2. $[Co(NH_3)_6]^{3+} > [Co(H_2O)_6]^{3+} > [Co(CN)_6]^{3-}$
3. $[Co(H_2O)_6]^{3+} < [Co(NH_3)_6]^{3+} > [Co(CN)_6]^{3-}$
4. $[Co(CN)_6]^{3-} < [Co(NH_3)_6]^{3+} < [Co(H_2O)_6]^{3+}$

Question

Indicate the complex ion which shows geometrical isomerism.

[NCERT EXEMPLAR]

1. $[Cr(H_2O)_4Cl_2]^+$ Ma_4b_2
2. $[Pt(NH_3)_3Cl]$ Ma_3b
3. $[Co(NH_3)_6]^{3+}$ Ma_6
4. $[Co(CN)_5(NC)]^{3-}$ Ma_5b

Question

The CFSE for octahedral $[CoCl_6]^{4-}$ is 18,000 cm^{-1}. The CFSE for tetrahedral $[CoCl_4]^{2-}$ will be

[NCERT EXEMPLAR]

1. 18,000 cm^{-1}
2. 16,000 cm^{-1}
3. 8,000 cm^{-1}
4. 20,000 cm^{-1}

H.W

NOTES

Question

Due to the presence of ambidentate ligands co-ordination compounds show isomerism. Palladium complexes of the type $[Pd(C_6H_5)_2(SCN)_2]$ and $[Pd(C_6H_5)_2(NCS)_2]$ are [NCERT EXEMPLAR]

1. linkage isomers
2. coordination isomers
3. ionisation isomers
4. geometrical isomers

Question

The compounds $[Co(SO_4)(NH_3)_5]Br$ and $[Co(SO_4)(NH_3)_5]Cl$ represent.

[NCERT EXEMPLAR]

1. linkage isomerism
2. ionisation isomerism
3. coordination isomerism
4. no isomerism

Question

What kind of isomerism exists between $[Cr(H_2O)_6)]Cl_3$(violet) and $[Cr(H_2O)_5Cl]Cl_2.H_2O$ (greyish-green) ?

[NCERT EXEMPLAR]

1. linkage isomerism
2. hydrate isomerism
3. ionisation isomerism
4. coordination isomerism

Question

Identify the optically active compounds from the following:

[NCERT EXEMPLAR]

(a) $[Co(en)_3]^{3+}$

(b) trans-$[Co(en)_2Cl_2]^{+}$

(c) cis-$[Co(en)_2Cl_2]^{+}$

(d) $[Cr(NH_3)_5Cl]$

1. a, c
2. c, d
3. b, c, d
4. a, b, c

Question

Which of the following complexes show linkage isomerism?

[NCERT EXEMPLAR]

(a) $[Co(NH_3)_5(NO_2)]^{2+}$

(b) $[Co(H_2O)_5CO]^{3+}$

(c) $[Cr(NH_3)_5SCN]^{2+}$

(d) $[Fe(en)_2Cl_2]^{+}$

1. a, b, c
2. a, d
3. a, c
4. a, b

Question

Copper sulphate dissolves in excess of KCN to give :

[AIPMT 2006]

1. $Cu(CN)_2$
2. $CuCN$
3. $[Cu(CN)_4]^{3-}$
4. $[Cu(CN)_4]^{2-}$

$K_3[Cu(CN)_4]$

Question

Which of the following carbonyls will have the strongest C–O bond?

[AIPMT Pre. 2011]

1. $Fe(CO)_5$
2. $Mn(CO)_6^+$
3. $Cr(CO)_6$
4. $V(CO)_6^-$

Question

The hybridization involved in complex $[Ni(CN)_4]^{2-}$ is (At. No. NI = 28)

[Re-AIPMT - 2015]

1. d^2sp^2
2. d^2sp^3
3. dsp^2
4. sp^3

H.W

Question

An example of a sigma bonded organometallic compound is :

[NEET 2017]

1. Ruthenocene
2. Grignard's reagent
3. Ferrocene
4. Cobaltocene

H.W

Question

The type of isomerism shown by the complex $[CoCl_2(en)_2]$ is

[NEET 2018]

1. Geometrical isomerism

$M(AA)_2b_2$

2. Coordination isomerism ✗

3. Ionization isomerism ✗

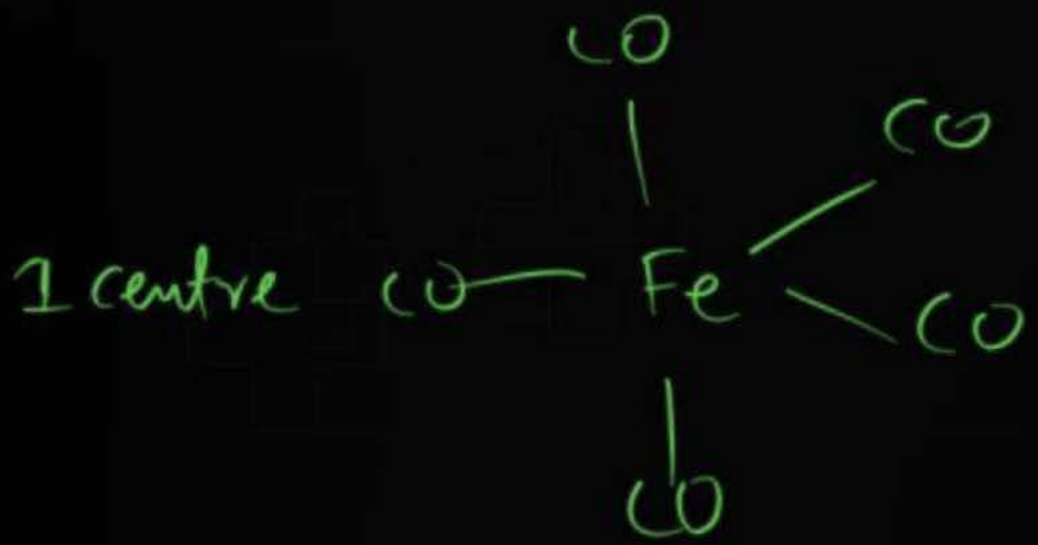
4. Linkage isomerism ✗

Question

Iron carbonyl, $Fe(CO)_5$ is

[NEET 2018]

1. tetranuclear
2. mononuclear
3. trinuclear
4. tetrahedral geometry and paramagnetic



Question

What is the correct electronic configuration of the central atom in $K_4[Fe(CN)_6]$ based on crystal field theory?

[NEET - 2019]

1. $t^4_{2g} e^2_g$
2. $t^6_{2g} e^0_g$
3. $e^3 t^3_2$
4. $e^4 t^2_2$

$d^6 \xrightarrow{SL} t_{2g}^6 e_g^0$

Question

Which of the following is not correct about carbon monoxide ?

[NEET - 2020]

1. It reduces oxygen carrying ability of blood.
2. The carboxyhaemoglobin (haemoglobin bound to CO) is less stable than oxyhaemoglobin.
3. It is produced due to incomplete combustion.
4. It forms carboxyhaemoglobin

Question

The coordination number and the oxidation state of the element 'E' in the complex $[E(en)_2(C_2O_4)]NO_2$ (where (en) is ethylene diamine) are, respectively

[JEE Main - 2008]

1. 6 and 2
2. 4 and 2
3. 4 and 3
4. 6 and 3

H.W

Question

A solution of $FeCl_3$ when treated with $K_4[Fe(CN)_6]$ gives a prussiun blue precipitate due to the formation of

[JEE Mains 2023]

1. $Fe[Fe(CN)_6]$
2. $Fe_3[Fe(CN)_6]_2$
3. $K[Fe_2(CN)_6]$
4. $Fe_4[Fe(CN)_6]_3$

(H.W)

Question

Which of the following are the example of double salt?

A. $FeSO_4.(NH_4)_2SO_4.6H_2O$

B. $CuSO_4.4NH_3H_2O$

C. $K_2SO_4.Al_2(SO_4).24H_2O$

D. $Fe(CN)_2.4KCN$

$[Cu(NH_3)_4]SO_4$

$K_4[Fe(CN)_6]$

Choose the correct answer.

[JEE Mains 2023]

1. A and B only
2. A, B and D only
3. A and C only
4. B and D only

Question

Which of the following complex will show largest splitting of d-orbitals?

[JEE Mains 2023]

1. $[FeF_6]^{3-}$
2. $[Fe(NH_3)_6]^{3+}$
3. $[Fe(C_2O_4)_3]^{3-}$
4. $[Fe(CN)_6]^{3-}$

Ligand strength $\propto \Delta_o$

Question

The magnetic moment of a transition metal compound has been calculated to be 3.87 B.M. The metal ion is

[JEE Mains 2023]

1. Mn^{2+}
2. V^{2+}
3. Cr^{2+}
4. Ti^{2+}

n=3

H.W

Question

The d-electronic configuration of $[CoCl_4]^{2-}$ in tetrahedral crystal field is $e^m t_2 n$.
Sum of "m" and "number of unpaired electrons" is _____.

[JEE Mains 2023]

4

3

$4+3=7$

$Co^{2+} \rightarrow d^7$

t_2

e

$e^4 t_2^3$

Question

Chiral complex from the following is:

Here en = ethylene diamine

[JEE Mains 2023]

1. cis - $[PtCl_2(NH_3)_2]$
2. cis - $[PtCl_2(en)_2]^{2+}$
3. trans - $[Co(NH_3)_4Cl_2]^{+}$
4. trans - $[PtCl_2(en)_2]^{2+}$

Question

The complex cation which has two isomers is:

[JEE Mains 2023]

1. $[Co(NH_3)_5Cl]^{2+}$

2. $[Co(NH_3)_5Cl]^{+}$

3. $[Co(H_2O)_6]^{3+}$

4. $[Co(NH_3)_5NO_2]^{2+}$ linkage

Question

The hybridization and magnetic behaviour of cobalt ion in $[Co(NH_3)_6]^{3+}$ complex, respectively is

[JEE Mains 2023]

1. d^2sp^3 and paramagnetic
2. d^2sp^3 and diamagnetic
3. sp^3d^2 and paramagnetic
4. sp^3d^2 and diamagnetic

H.W

Question

The number of paramagnetic species from the following is _____.

$[Ni(CN)_4]^{2-}$, $[Ni(CO)_4]$, $[NiCl_4]^{2-}$, $[Fe(CN)_6]^{4-}$, $[Cu(NH_3)_4]^{2+}$, $[Fe(CN)_6]^{3-}$ and $[Fe(H_2O)_6]^{2+}$

[JEE Mains 2023]

H.W

NOTES

Question

Match List I with List II [JEE Mains 2023]

Choose the correct answer from the options given below:

1. A-IV, B-I, C-III, D-II
2. A-III, B-I, C-II, D-IV
3. A-II, B-III, C-IV, D-I
4. A-III, B-II, C-I, D-IV

List I (Coordination entity)		List II (Wavelength of light absorbed in nm)	
A.	$[CoCl(NH_3)_5]^{2+}$	I.	310
B.	$[Co(NH_3)_6]^{3+}$	II.	475
C.	$[Co(CN)_6]^{3-}$	III.	535
D.	$[Cu(H_2O)_4]^{2+}$	IV.	600

Question

Total number of moles of AgCl precipitated on addition of excess of $AgNO_3$ to one mole each of the following complexes $[Co(NH_3)_4Cl_2]Cl$, $[Ni(H_2O)_6]Cl_2$, $[Pt(NH_3)_2Cl_2]$ and $[Pd(NH_3)_4]Cl_2$ is _____.

[JEE Mains 2023]

0 AgCl 2 AgCl 1 AgCl 2 AgCl

(Sum) (5) AgCl.

Question

Correct order of spin only magnetic moment of the following complex ions is:
(Given At. no. Fe: 26, Co: 27)

[JEE Mains 2023]

1. $[FeF_6]^{3-} > [Co(C_2O_4)_3]^{3-} > [CoF_6]^{3-}$
   d^5 d^6 d^6
2. $[CoF_6]^{3-} > [FeF_6]^{3-} > [Co(C_2O_4)_3]^{3-}$
3. $[Co(C_2O_4)_3]^{3-} > [CoF_6]^{3-} > [FeF_6]^{3-}$
4. $[FeF_6]^{3-} > [CoF_6]^{3-} > [Co(C_2O_4)_3]^{3-}$
   $t_{2g}^3 e_g^2$, $n=5$ $t_{2g}^4 e_g^2$, $n=4$

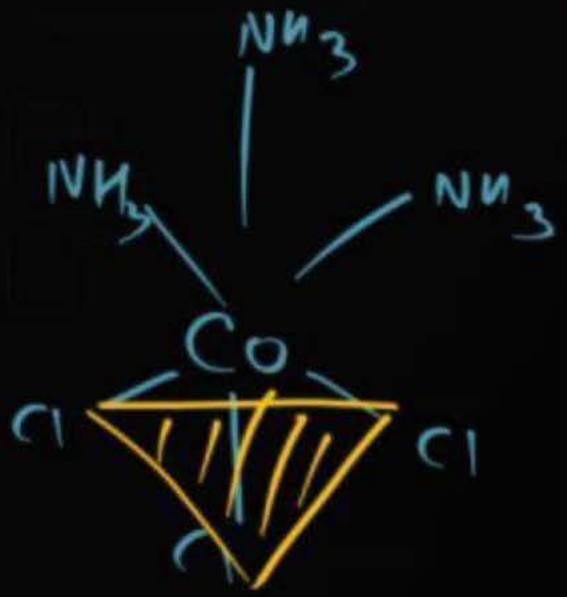
Co^{3+} ''O'' donor (S.L)
d^6 S.L $t_{2g}^6 e_g^0$, $n=0$

Question

The Cl – Co – Cl bond angle values in a fac-$[Co(NH_3)_3Cl_3]$ complex is/are:

[JEE Mains 2023]

1. 90° & 120°
2. 90°
3. 90° & 180°
4. 180°



Cl – Co – Cl = 90°

Question

To inhibit the growth of tumours, identify the compounds used from the following:

A. EDTA

B. Coordination Compounds of Pt Zeise's Salt

C. D – Penicillamine

D. Cis - Platin

Choose the correct answer from the option given below:

[JEE Mains 2023]

1. C and D Only
2. B and D Only
3. A and B Only
4. A and C Only

THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture - 01 | Inorganic Chemistry

The d and f-Block Elements

By - Mohit Dadheech (MD Sir)

Topics to be covered

1. d-Block Elements
   - Introduction
   - Properties.
2.

Introduction :

elements in which last e⁻ enters into (n-1)d subshell

If e⁻ enters into 3d → 3d series (n=4)
4d → 4d series (n=5)
5d → 5d series (n=6)
6d → 6d series
↓
Kaam ni aati? (n=7)

Transition Element :

According to IUPAC, transition metals are defined as metals which have incomplete d subshell either in neutral atom or in their ions. → Known O.S

Incomplete → d^1 to d^9
(Partially Filled)

d^0, d^{10} → ~~Transition~~ Elements

* group 12th Zn, Cd, Mg, Cn

~~F.E~~ ∵ d^{10} configuration

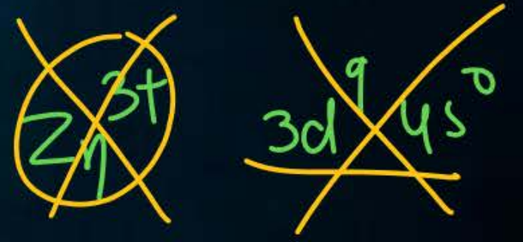
NCERT Intext question

Why Ag is T.E Although it has d^{10} configuration

Ans

$Ag^{0} \xrightarrow{-e^-} Ag^{+1} \xrightarrow{-e^-} Ag^{2+}$

$4d^{10}5s^{1}$ $\quad$ $4d^{10}5s^{0}$ $\quad$ $4d^{9}5s^{0}$



Ag is d^9 in its +2 O.S

thats why Ag is Considered as T.E.

General Electronic configuration of d-Block

$(n-1)d^{1-10}$ ns^{1-2}

$ns^2 \rightarrow$ normal

$ns^0, ns^1 \rightarrow$ Exceptional

* $ns^0 \rightarrow$ For Pd only

$Z = 46$

detailed Configuration

"Covered this in the Periodic Table
please revise From there" 🙂

Important properties of d block elements

- Atomic size
- Ionization Enthalpy
- Spin only magnetic moment
- Alloy formation
- Catalytic power
- Interstitial compound formation
- Variable oxidation state
- Melting point
- Standard reduction potential

Covered in Coordination Comp Chapter.

- **Complex formation properties**
- **Colour of aqueous ion** (d^0, d^{10} colourless)

Atomic Size :-
Ionisation Enthalpy.

Already Covered in PT chapter.
Please Revise.

Spin only magnetic moment

$$\mu = \sqrt{n(n+2)}$$

μ = n point something

Ex Cr^{3+} d^3 $n=3$ $\sqrt{3(3+2)}$

$\sqrt{15} \Rightarrow 3.\ldots$

Jitna Unpaired e^- Utna point Something

d^0, d^{10} → Diamagnetic → Door From Magnetic Field.

Paramagnetic → Pass Magnetic Field Ke.

Ferromagnetic → Full pass Magnetic Field Ke.

Alloy formation

Alloys are formed by atoms with metallic radii that are within about 15 percent of each other.

Ex. : Brass (Cu(60%) + Zn(40%)

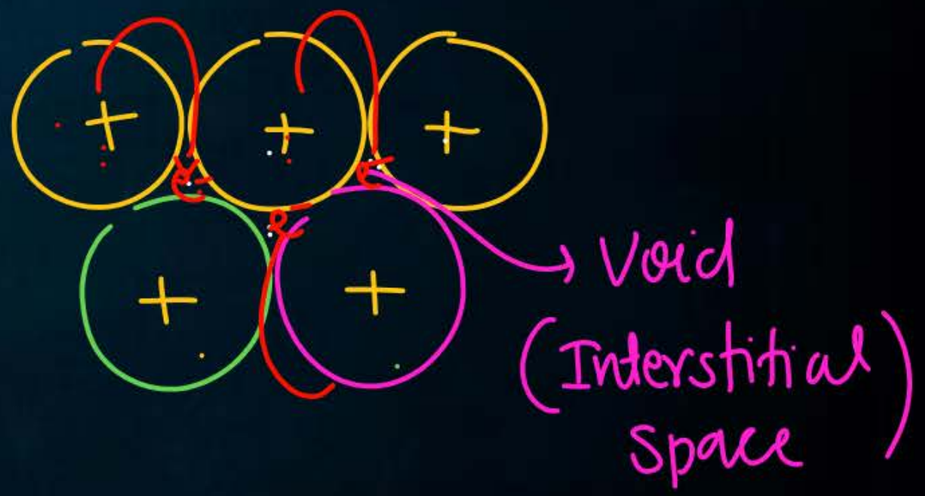
German silver(Cu(1) + Zn(1) + Ni(2))

Bronze (Cu + Sn)

ays

Metallic Lattice

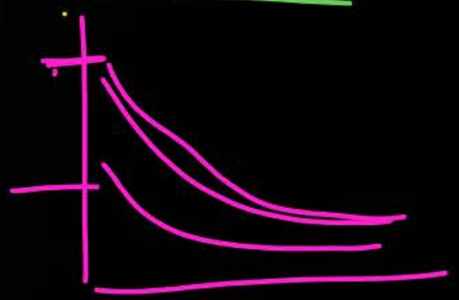
Alloys have more M.p than Pure metals and Harder than Pure metals.



4.3.14 Alloy Formation

NCERT

An alloy is a blend of metals prepared by mixing the components. Alloys may be homogeneous solid solutions in which the atoms of one metal are distributed randomly among the atoms of the other. Such alloys are formed by atoms with metallic radii that are within about 15 percent of each other. Because of similar radii and other characteristics of transition metals, alloys are readily formed by these metals. The alloys so formed are hard and have often high melting points. The best known are ferrous alloys: chromium, vanadium, tungsten, molybdenum and manganese are used for the production of a variety of steels and stainless steel. Alloys of transition metals with non transition metals such as brass (copper-zinc) and bronze (copper-tin), are also of considerable industrial importance.



Catalytic Properties

Reasons < (i) Variable oxidation state ✓
(ii) Complex formation property with Reactant

$N_2 + 3H_2 \xrightarrow{Fe(Powder)} 2NH_3$ (Haber's Process)

$SO_2 + 1/2O_2 \xrightarrow{V_2O_5} SO_3$ (Contact Process)

Veg. Oil $\xrightarrow[H_2]{Ni/Pd}$ Veg. ghee

$CH \equiv CH \xrightarrow[PdCl_2]{} CH_3CHO$ (Wacker Process)

Ziegler Nata $TiCl_4 + Al(C_2H_5)_3$ ✓
(use in polymerization)

Wilkinson catalyst $(PPh_3)_3$ RhCl
(Hydrogenation of alkene)

Catalytic Properties

Reasons (i) Variable oxidation state

(ii) Complex formation property ✓

$N_2 + 3H_2 \xrightarrow{\text{Fe Powder.}} 2NH_3$ (Habers Process)

$SO_2 + 1/2O_2 \xrightarrow{V_2O_5} SO_3$ (Contact Process)

$\text{Veg. Oil} \xrightarrow[H_2]{Ni/Pd} \text{Veg. ghee}$

$CH \equiv CH \xrightarrow[PdCl_2]{} CH_3CHO$ (Wacker Process)

Ziegler Nata $TiCl_4 + Al(C_2H_5)_3$
(use in polymerization)

Wilkinson catalyst $(PPh_3)_3$ RhCl
(Hydrogenation of alkene)

} Coordination Compounds

NCERT

4.3.12 Catalytic Properties

The transition metals and their compounds are known for their catalytic activity. This activity is ascribed to their ability to adopt multiple oxidation states and to form complexes. Vanadium(V) oxide (in Contact Process), finely divided iron (in Haber's Process), and nickel (in Catalytic Hydrogenation) are some of the examples. Catalysts at a solid surface involve the formation of bonds between reactant molecules and atoms of the surface of the catalyst (first row transition metals utilise 3d and 4s electrons for bonding). This has the effect of increasing the concentration of the reactants at the catalyst surface and also weakening of the bonds in the reacting molecules (the activation energy is lowering).

Also because the transition metal ions can change their oxidation states, they become more effective as catalysts. For example, iron(III) catalyses the reaction between iodide and persulphate ions.

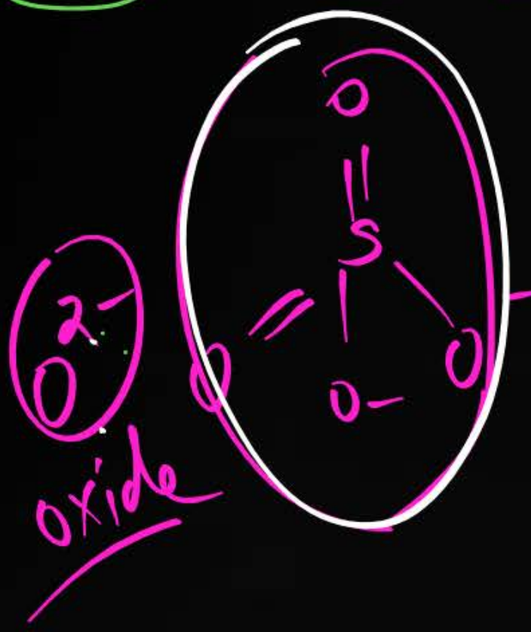
$$2\ I^- + S_2O_8^{2-} \rightarrow I_2 + 2\ SO_4^{2-}$$

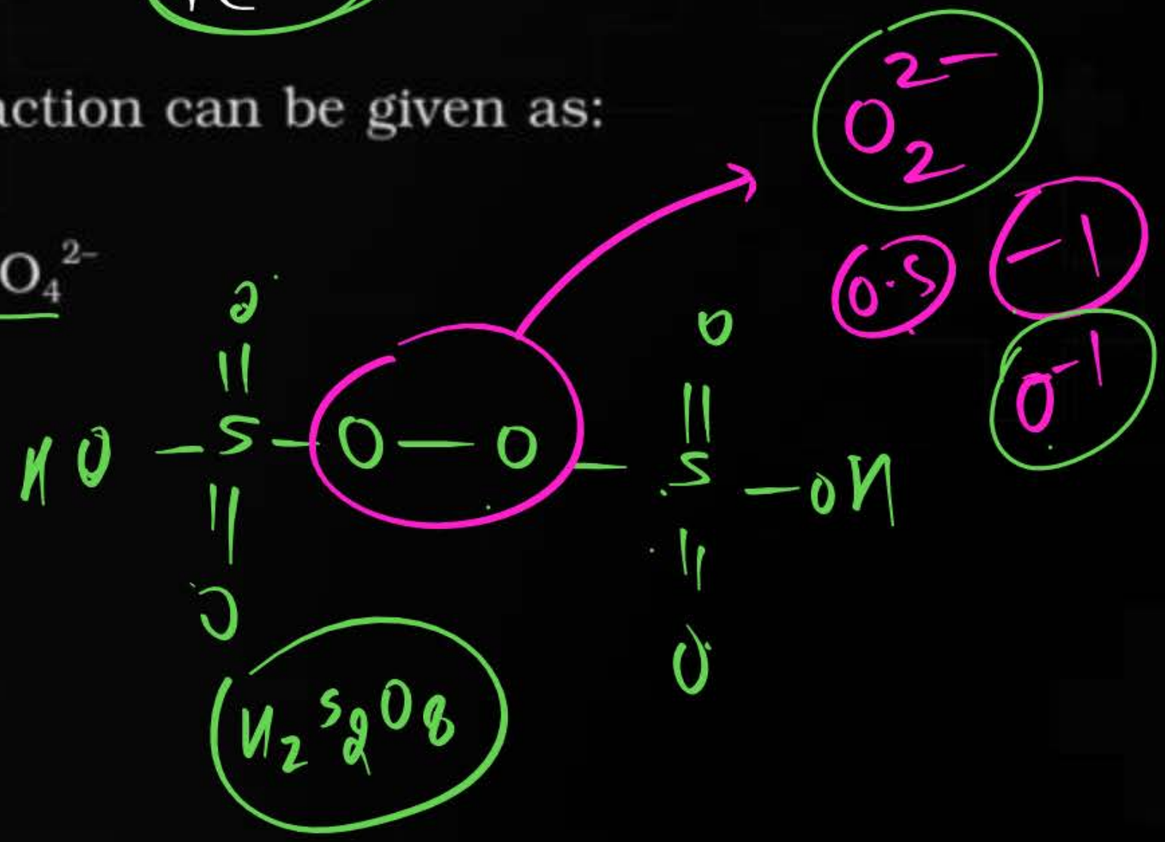
An explanation of this catalytic action can be given as:

$$2\ Fe^{3+} + 2\ I^- \rightarrow 2\ Fe^{2+} + I_2$$

$$2\ Fe^{2+} + S_2O_8^{2-} \rightarrow 2\ Fe^{3+} + 2SO_4^{2-}$$

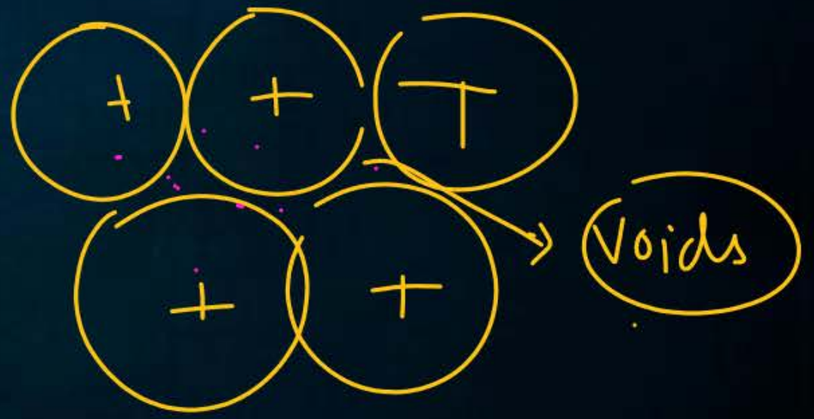
Fe^{3+}





Interstitial compound formation (V.Imp)

- These can be prepared by trapping of small sized non-metal like B, H, C, N in interstitial space of crystal lattice of metals.
- Non-stoichiometric compound
- Neither ionic nor covalent
- Hardness ↑ (NiB → hardness similar to diamond)
- M.P. ↑
- Conductance remain same ✓
- Chemically inert ✓



Melting Points :-

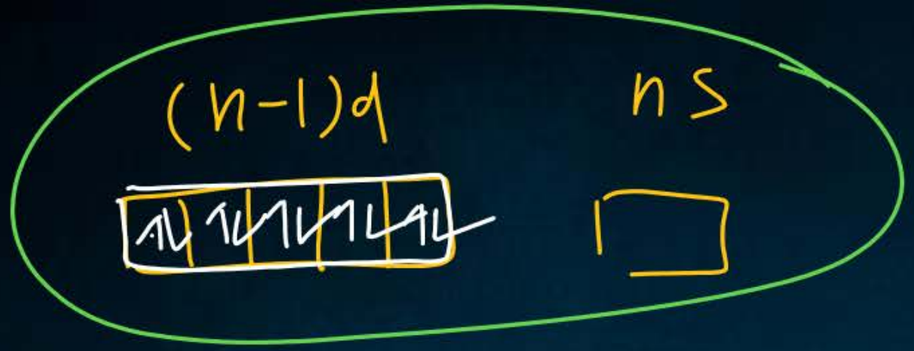
gen. High M.P

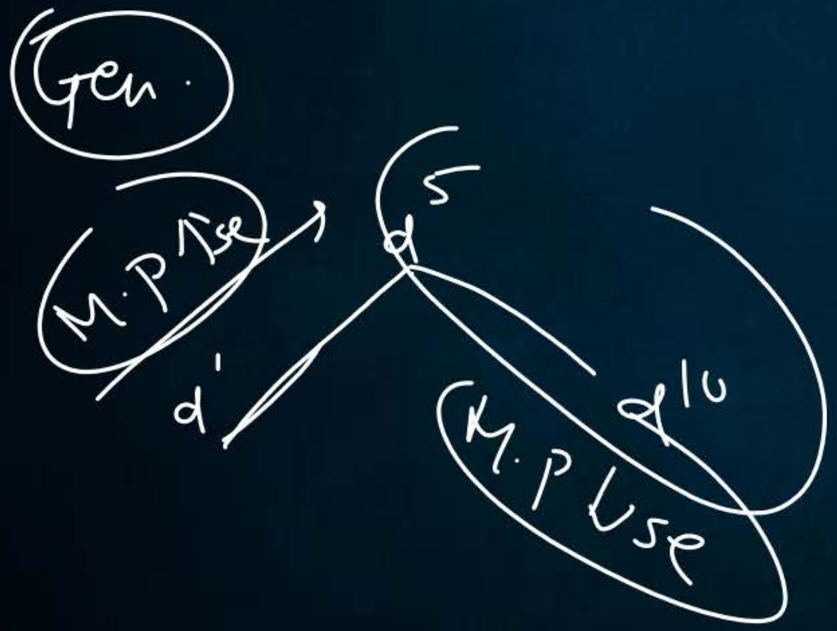
Reason :- More no. of e^- are involved into Bonding.
($(n-1)d$ e^- in addition to ns)

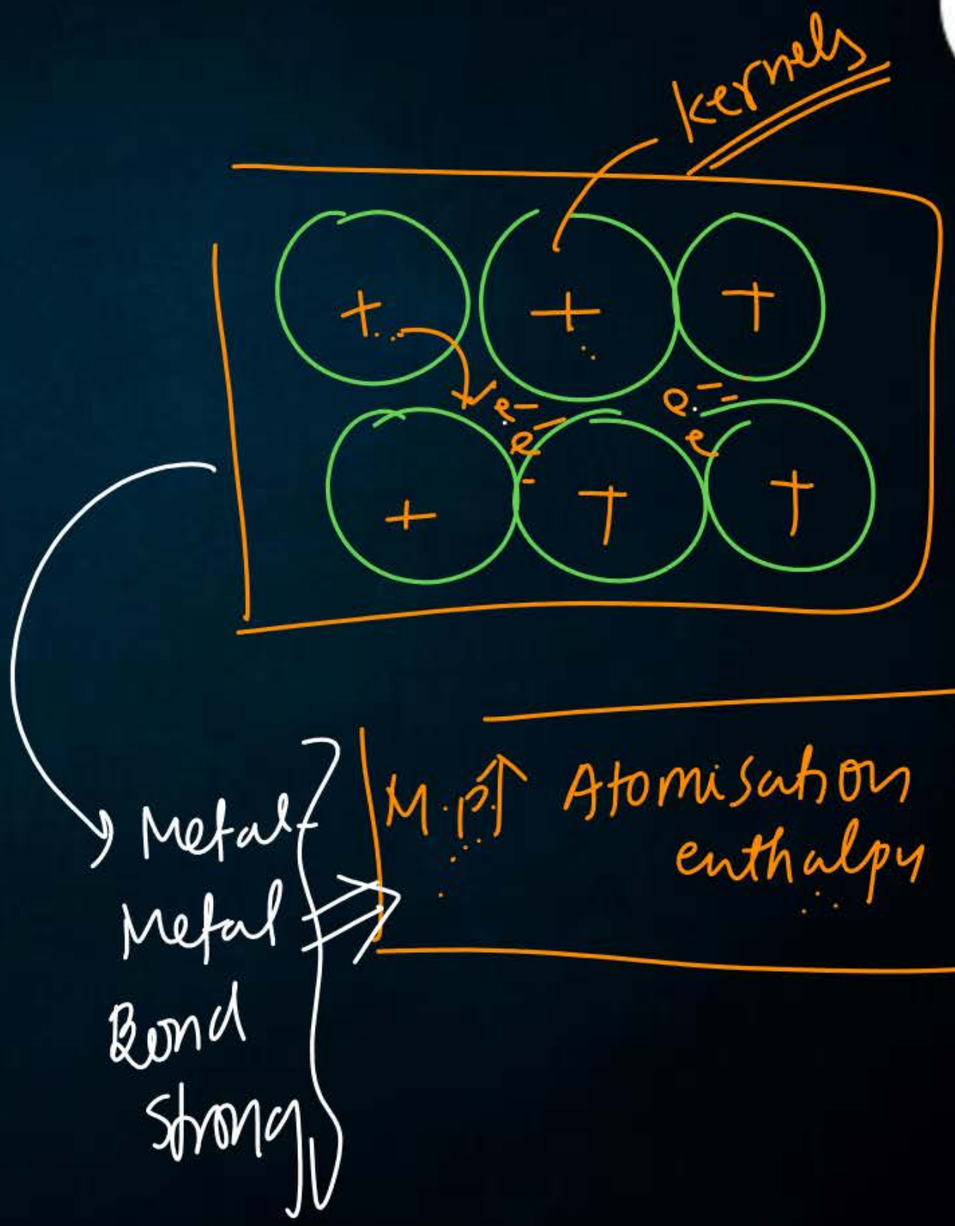
* Mainly depends on no. of Unpaired e^- in $(n-1)d$ subshell.

* In any series. M.P. is max at d^5 Configuration

NOTE Lower value of Mn & Tc is due to weak & diff packing in Solid

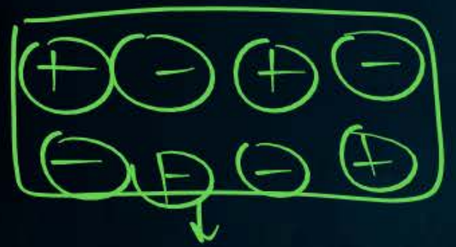

(n-1)d
ns

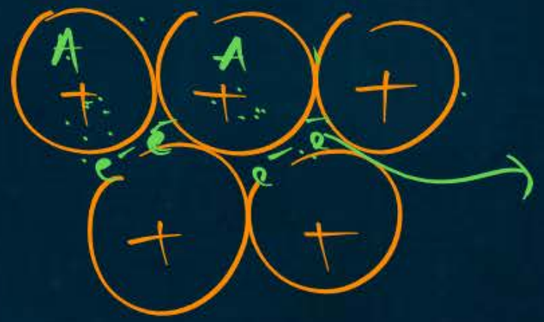

Gen.
M.P Use
d⁵
d¹
d¹⁰
M.P Use


kernels
Metal
Metal
Bond
Strong
M.P. ↑ Atomisation enthalpy ↑

$M_{(s)} \longrightarrow M_{(l)}$

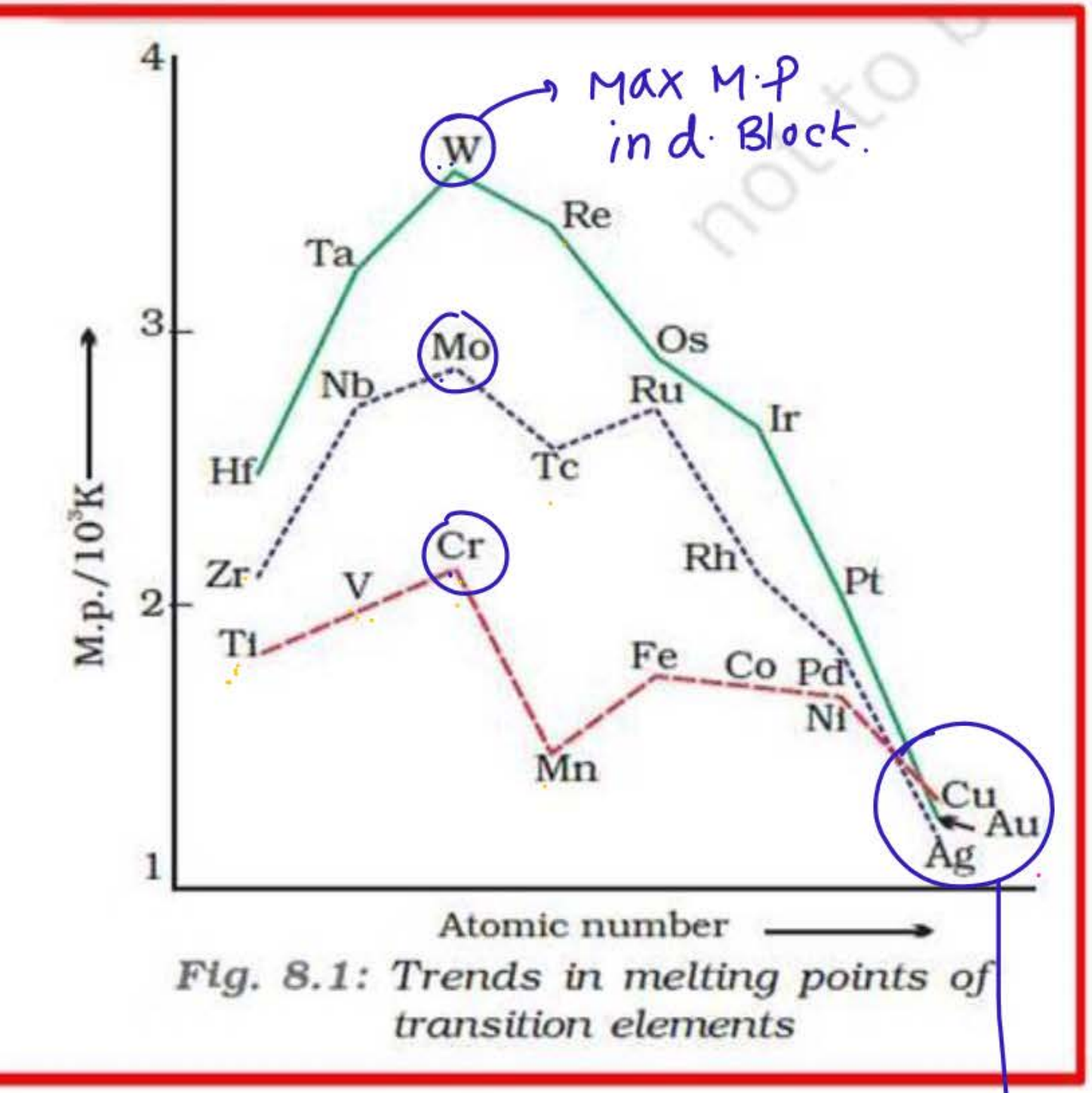
M.P





no. of $\bar{e}$ involved in Bonding ↑se → Interatomic Interaction ↑se → Metallic Bonding ↑se

M.P ↑



Max M·P in d· Block.

Fig. 8.1: Trends in melting points of transition elements

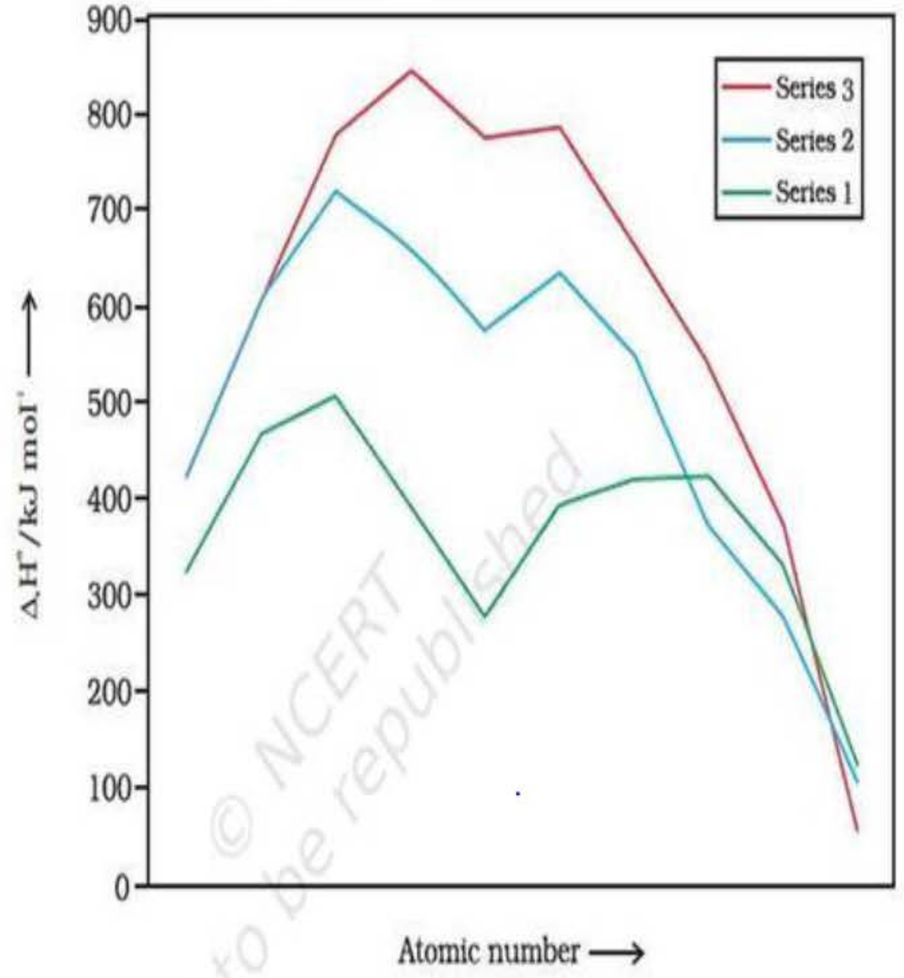


Fig. 8.2 Trends in enthalpies of atomisation of transition elements

© NCERT not to be republished

Cu > Au > Ag

only 11th group

Order of M.P

* Max in d-Block → (W)

* Max in 3d, 4d, 5d series Cr, Mo, W respectively.
* Min in 3d series → Zn.

Top to bottom In groups

- 3d > 4d > 5d (For group 3 & 12)
- 3d < 4d < 5d (4th to 10th)
- 3d > 5d > 4d (only For group-11)

Cu > Au > (Ag) → due to low M.P

Ag is not used in electric wires.

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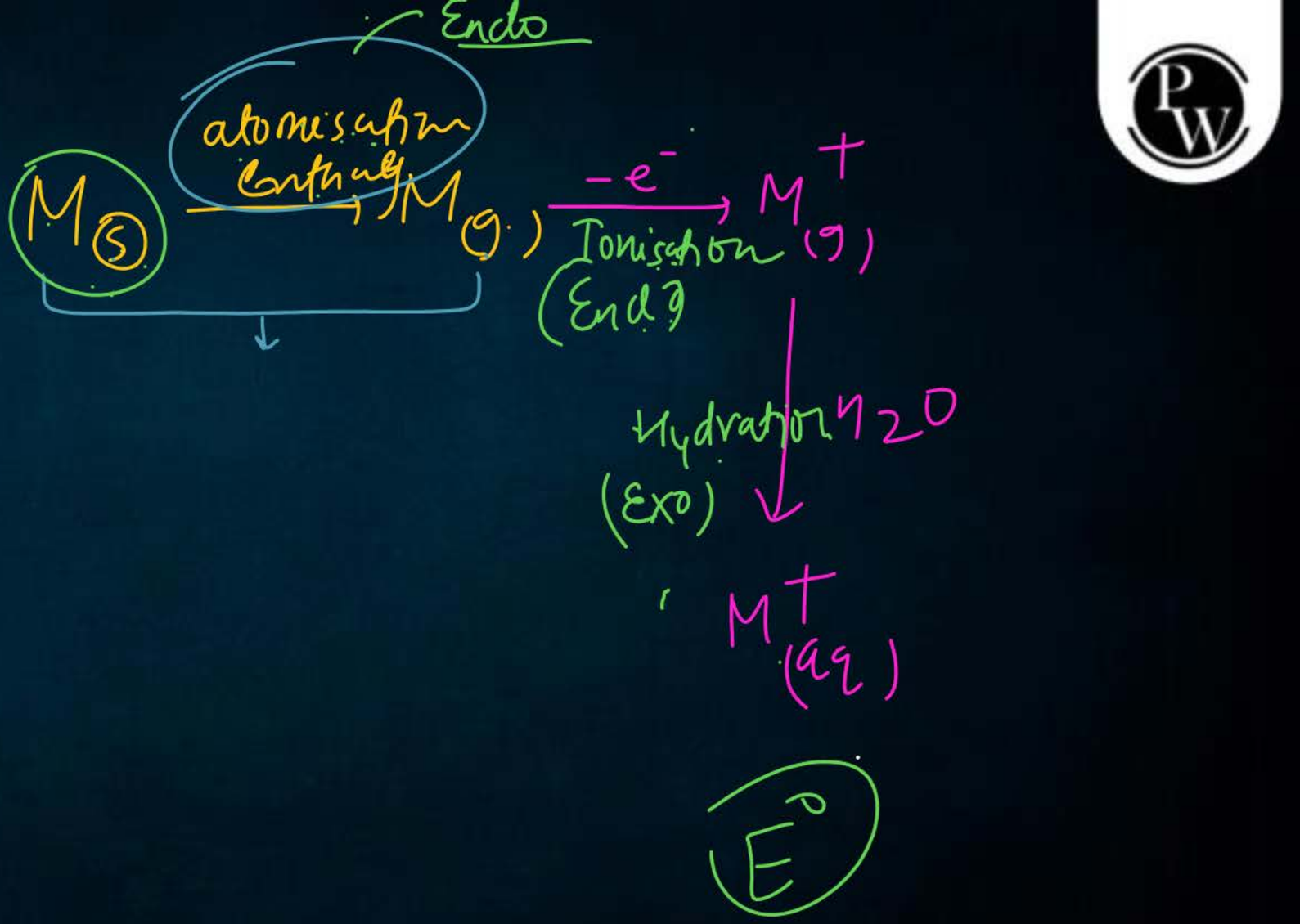
∵ d^{10} Weak Metal-Metal Bonding

The transition metals (with the exception of Zn, Cd and Hg) are very hard and have low volatility. Their melting and boiling points are high. Fig. 4.1 depicts the melting points of transition metals belonging to 3d, 4d and 5d series. The high melting points of these metals are attributed to the involvement of greater number of electrons from (n-1)d in addition to the ns electrons in the interatomic metallic bonding. In any row the melting points of these metals rise to a maximum at d5 except for anomalous values of Mn and Tc and fall regularly as the atomic number increases. They have high enthalpies of atomisation which are shown in Fig. 4.2. The maxima at about the middle of each series indicate that one unpaired electron per d orbital is particularly favourable for strong interatomic interaction. In general, greater the number of valence electrons, stronger is the resultant bonding. Since the enthalpy of atomisation is an important factor in determining the standard electrode potential of a metal, metals with very high enthalpy of atomisation (i.e., very high boiling point) tend to be noble in their reactions (see later for electrode potentials).


Endo
atomisation
Enthalpy
$M_{(s)}$
$M_{(g)}$
$-e^-$
$M^+_{(g)}$
Ionisation
(Endo)
Hydration H_2O
(Exo)
$M^+_{(aq)}$
E°

NCERT

Another generalisation that may be drawn from Fig. 4.2 is that the metals of the second and third series have greater enthalpies of atomisation than the corresponding elements of the first series; this is an important factor in accounting for the occurrence of much more frequent metal – metal bonding in compounds of the heavy transition metals.

H.W

Padh Lo
Samajh
Aa Jaega.

3d
↓
4d
↓
5d

Zeff ↑se → Frequent Metallic Bonding

Metallic Bond strength ↑se

↓

Atomisation enthalpy

generally ↑se

QUESTION

Which of the following element has lowest melting point :

[AIIMS 2013]

1. Cr
2. Fe
3. Ni
4. Cu

H.W

QUESTION

In which of the following pairs are both the ions coloured in aqueous solution ?
(At. no. : Sc = 21, Ti = 22, Ni = 28, Cu = 29, Co = 27)

[AIPMT-2006]

1. Ni^{2+}, Cu^{+}

2. Ni^{2+}, Ti^{3+}

3. Sc^{3+}, Ti^{3+}

4. Sc^{3+}, Co^{2+}

QUESTION

Identify the incorrect statement among the following

[AIPMT-2007]

1. Lanthanoid contraction is the accumulation of successive shrinkages.

2. As a result of lanthanoid contraction, the properties of 4d series of the transition elements have no similarities with the 5d series of elements.

3. Shielding power of 4f electrons is quite weak.

4. There is a decrease in the radii of the atoms or ions as one proceeds from La to Lu.

QUESTION

The correct order of decreasing second ionisation enthalpy of Ti(22), V(23), Cr(24) and Mn(25) is :-

[AIPMT-2008]

H.W

1. Mn > Cr > Ti > V
2. Ti > V > Cr > Mn
3. Cr > Mn > V > Ti
4. V > Mn > Cr > Ti

QUESTION

Which of the following pairs has the same size?

[AIPMT-2010]

1. Zn^{2+}, Hf^{4+}
2. Fe^{2+}, Ni^{2+}
3. Zr^{4+}, Ti^{4+}
4. Zr^{4+}, Hf^{4+}

H.W

QUESTION

Which one of the following ions has electronic configuration [Ar] 3d6 ? (At. nos. Mn = 25, Fe = 26, Co = 27, Ni = 28) [AIPMT-2010]

1. Co^{3+}
2. Ni^{3+}
3. Mn^{3+}
4. Fe^{3+}

H·W

QUESTION

Which of the following ions will exhibit colour in aqueous solutions ?

[AIPMT-2010]

1. $Sc^{3+}(z = 21)$
2. $La^{3+}(z = 57)$
3. $Ti^{3+}(z = 22)$
4. $Lu^{3+}(z = 71)$

H.W

QUESTION

Magnetic moment 2.84 B.M. is given by :-
(At . no.), Ni = 28, Ti = 22, Cr = 24, Co = 27 [AIPMT 2015]

1. Ti^{3+}
2. Cr^{2+}
3. Co^{2+}
4. Ni^{2+}

H.W

QUESTION

Because of lanthanoid contraction, which of the following pairs of elements have nearly same atomic radii ? (Numbers in the parenthesis are atomic numbers) **[AIPMT 2015]**

1. Zr (40) and Nb (41)

H.W

2. Zr (40) and Hf (72)

3. Zr (40) and Ta (73)

4. Ti (22) and Zr (40)

QUESTION

Transition elements show magnetic moment due to spin and orbital motion of electrons. Which of the following metallic ions have almost same spin only magnetic moment ?

(a) Co^{2+} (b) Cr^{2+} (c) Mn^{2+} (d) Cr^{3+} [NCERT Exemplar]

1. a, b
2. b, c
3. c, d
4. a, d

H.W

QUESTION

Which of the following oxide of chromium is amphoteric in nature?

1. CrO
2. Cr_2O_3
3. CrO_3
4. CrO_5

H.W

QUESTION

Which of the following element has lowest melting point :

[AIIMS 2013]

1. Cr
2. Fe
3. Ni
4. Cu

H.W

Homework

PYQs
given in pre Slides

THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture - 02 | Inorganic Chemistry

The d and f-Block Elements

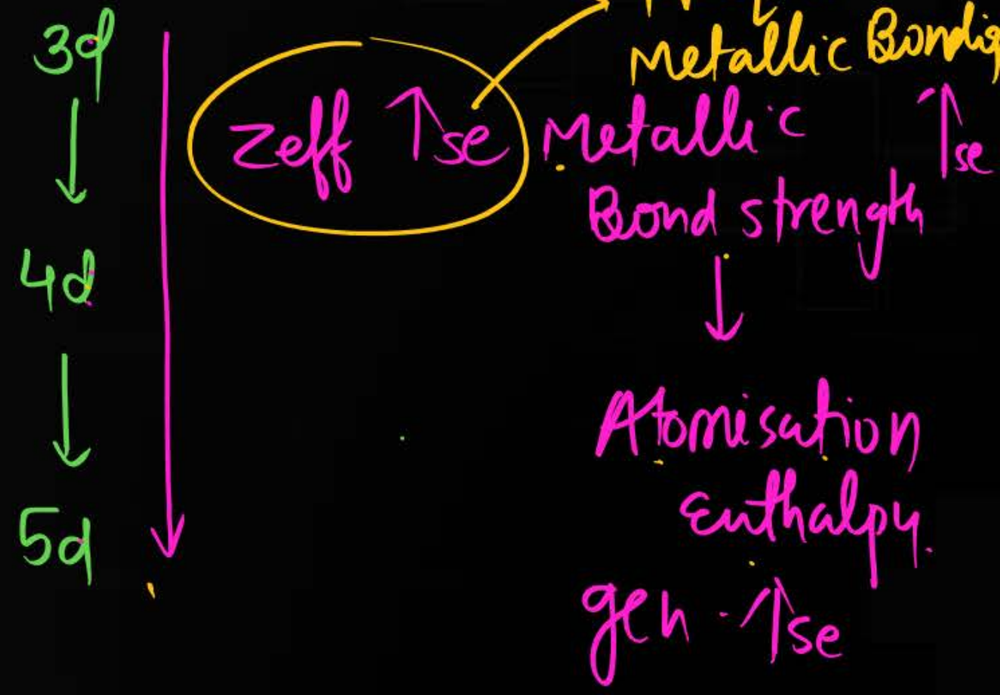
By - Mohit Dadheech (MD Sir)

Topics *to be covered*

1. Oxidation states
2. SRP Values & Reactivity.

NCERT

Another generalisation that may be drawn from Fig. 4.2 is that the metals of the second and third series have greater enthalpies of atomisation than the corresponding elements of the first series; this is an important factor in accounting for the occurrence of much more frequent metal – metal bonding in compounds of the heavy transition metals.



Oxidation States

Range

Variable O.S

3d ⇒ us

(n-1)d e⁻ } with ns e⁻
unpaired e⁻

energy gap low

no. of e⁻ are more available

Stability

M.O.S group ↑se (stability)
(inverse of Inert pair effect)

Fluorides stability

oxides & stability

L.O.S stability

↑ acceptor ligands

Variable oxidation state

more no. of e^- are available.
more no. of O.S

Due to low energy gap between ns & (n – 1)d.

NOTE :

$Sc \rightarrow +2$ $\qquad$ $Cr \rightarrow +1$

$Fe, Co \rightarrow +5$

↓

does not exist.

ns
↓
$e^{\ominus}$ of ns = Y

(n – 1)d
↓
unpaired $e^{\ominus}$ of (n – 1) d = X

O.S. range = Y to X + Y

For Ex Mn $3d^5 4s^2$

X Y

↓ ↓

5 2

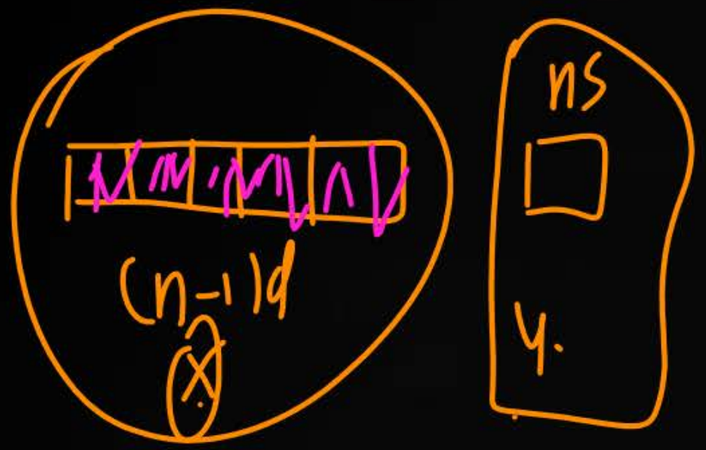
NEET 2018

Range 2 to 7

Mn^{2+} to Mn^{7+}

Table 4.3: Oxidation States of the first row Transition Metal (the most common ones are in bold types)

Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
	+2	+2	+2	**+2**	**+2**	**+2**	**+2**	+1	**+2**
+3	+3	+3	**+3**	+3	**+3**	**+3**	+3	**+2**	
	+4	+4	+4	+4	+4	+4	+4		
		+5	+5	+5		~~+5~~			
			+6	+6	+6				
				+7					



d^1 — d^5 → Unpaired e^- ↑se in (n-1)d
Range of 0-1 ↑se

d^5 — d^{10} → Pairing starts → n ↓se in (n-1)d
Range 0-5 ↓se

Imp. Points:-

(n-1)d ... ns (Low energy gap) [(n-1)d e⁻]

(i) Variable O.S is due to more no. of e⁻ available in addition to ns e⁻

(ii) greatest no. of O.S is present in middle of series (Ex. Mn) (Range)

(iii) At Both ends (starting & Ending) no. of O.S is less (Range)

Reason

(iv) In starting d e⁻ are less & in end of series e⁻ avaible. but orbitals are less to share

(v) In transition elements O.S differ from each other by unit of one

Ex. V^{+2}, V^{+3}, V^{+4}, V^{+5} etc

(vi) In d-Block elements stability of H.O.S ↑se down the group which is opposite of p-Block

→ stability of H.O.S ↓se down the group "Inert pair effect"

For-Ex.

V.V.Imp

Cr^{+6}

Mo^{+6}

W^{+6}

Stability of +6 ↑se From Cr to W

H.O.S

Higher oxi. state

$Cr_2O_7^{2-}$ / CrO_3

less stable +6

More easy to get reduced.

Work as O.A.

MoO_3 WO_3

More stable in +6

Can not work as O.A

(vii) Lower o.s of Metals (−ve or zero) can be stabilized by π acid ligands.

- Coordination Compounds
- Synergic Bonding
- π acceptor / π acid / non classical ligands

CN^- CO etc

Stability of higher oxidation states in Halides and oxides of d-block elements

O^{2-} F^-

Imp. Points :-

F → 4.0
O → 3.5

(1) H.O.S of Metals are stabilize in Presence of oxygen & Fluorine due to High E.N of oxygen & Fluorine.

(2) Oxygen is more capable to stabilize H.O.S of Metals than Fluorine due to its ability to form multiple bonds with Metal

Ex $Mn^{+2}F_2$, $Mn^{+3}F_3$, $Mn^{+4}F_4$

MnF_5^-, MnF_6, MnF_7 ← do not exist due to Steric Hindrance.

Mn_3O_4

Mn_2O_7

Mn_2O_3

MnO_4^- (Mn^{+7})

MnO_4^{2-} (Mn^{+6})

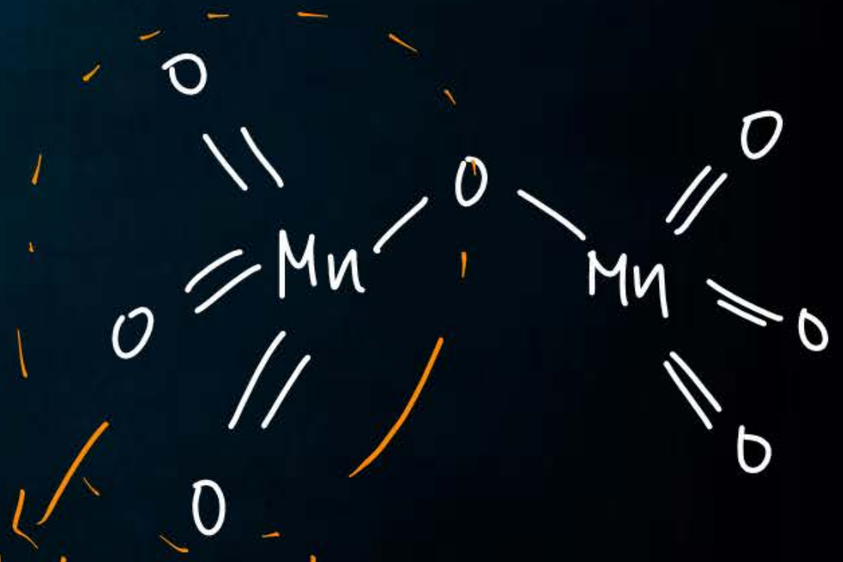
MnO_3F ✓

Stable

1 Bridging "O"

Covalent Compds.

green & oily



Tetrahedral Unit

total two tetrahedral Units

(3) In Case of Simple Halides $[MX_n]$ H.O.S achieved are +4, +5, +6.

Ex: TiX_4, VF_5, CrF_6

(4.) Fluorine Can stabilize H.O.S due to two Reasons:-

(i) due to High Lattice Energy:

When Compounds are Ionic in nature

Ex CoF_3

Small size F^-

$r^- \downarrow$ L.E $\uparrow$

(ii) due to High Bond Energy.

when Compound is Covalent Ex $\overset{+5}{V}F_5$, $\overset{+6}{Cr}F_6$

(5) Beyond Mn only FeX_3 & CoF_3 trihalides are Known.

$CoCl_3$
$CoBr_3$

Q which of the Following transition metal can not form trihalides.

(1) Fe
(2) Mn
(3) Zn
(4) Ni

(6) Gen. Metal Fluorides are Unstable in Lower O.S

Ex. 1. $\overset{+2}{V}X_2$ $(X = Cl/Br/I)$

~~VF_2~~

+2 L.O.S of V

$F_2 \rightarrow O.A$

$I^- \rightarrow R.A$

Imp Ex. 2 $\overset{+1}{Cu}X$ $[X = Cl/Br/I]$

Note $Cu^{2+} + I^- \longrightarrow Cu^+ + I_2$ (e⁻ transfer)

~~$\overset{+2}{Cu}I_2$~~ (R.A)

$\overset{+1}{Cu_2}I_2$

~~CuI_2~~

$\overset{+1}{Cu_2}I_2$ ✓

Imp (7) Cu^+ Compounds are unstable in aq. Solutions & undergo disproportionation.

$$2Cu^{+}_{(aq)} \longrightarrow Cu^{2+} + Cu^{0}$$

Cu^+ Cu^+ ← e^-

Cu^0 Cu^{2+}

Imp (8) $Cu^{2+}_{(aq)}$ ions are more stable than $Cu^{+}_{(aq)}$ ions due to High Hydration Energy of $Cu^{2+}_{(aq)}$

4.3.10 Formation of Coloured Ions

Reason d–d transition. (d^1–d^9)

When an electron from a lower energy d orbital is excited to a higher energy d orbital, the energy of excitation corresponds to the frequency of light absorbed (Unit 5). This frequency generally lies in the visible region. The colour observed corresponds to the complementary colour of the light absorbed. The frequency of the light absorbed is determined by the nature of the ligand. In aqueous solutions where water molecules are the ligands, the colours of the ions observed are listed in Table 4.8. A few coloured solutions of d–block elements are illustrated in Fig. 4.5.

Cu^{2+} → Blue ✓

Ni^{2+} → green ✓

* d^0 & d^{10} Colourless in aq. medium (ligand H_2O)

* Imp Ex :-

Zn^{+2} d^{10} ✓

Colourless

Fe^{2+} green ✓

Fe^{3+} yellow ✓

Sc^{+3} . Colourless (d^1) ✓

Ti^{+4} . — n — (d^0) ✓

QUESTION

Which of the following transition element do not exhibit variable oxidation state ?

1. Sc
2. Zn
3. Both
4. None

Standard Reduction Potential (E°)

$E^\circ_{Cu^{2+}/Cu} = +0.34$

(i) $E^\circ_{M^{2+}/M}$ $\quad M^{2+} \longrightarrow M$

* All 3d series metals have -ve value except Cu.
* On moving Left to right values of $E^\circ_{M^{2+}/M}$ become less negative. (Reason → L→R Gen. $I.E_1$ & $I.E_2$ ↑se)
* For Mn, Zn & Ni Value is more -ve than Expectation.

$E^\circ_{Mn^{2+}/M}$ $\quad Mn^{2+} \rightarrow d^5$

$E^\circ_{Zn^{2+}/Zn}$ $\quad Zn^{2+} \rightarrow d^{10}$ — stable.

$E^\circ_{Ni^{2+}/Ni}$ $\quad Ni^{+2}$ → Highest $H.E$ in 3d series makes it stable in +2 state

E°	+ve	−ve
ΔG	-ve	+ve
Process	Spont.	non spont.

The unique behaviour of Cu, having a positive $E^{\ominus}$ accounts for its inability to liberate H_2 from acids. Only oxidising acids (nitric and hot concentrated sulphuric) react with Cu, the acids being reduced. The high energy to transform Cu(s) to $Cu^{2+}(aq)$ is not balanced by its hydration enthalpy. The general trend towards less negative $E^{\ominus}$ values across the series is related to the general increase in the sum of the first and second ionisation enthalpies. It is interesting to note that the value of $E^{\ominus}$ for Mn, Ni and Zn are more negative than expected from the trend.

$Zn + H^+ \longrightarrow Zn^{2+} + H_2\uparrow$

$Cu^{2+} \longrightarrow Cu \quad E^\circ = +ve$ (+0.34)

$Cu \longrightarrow Cu^{2+} \quad E^\circ = -ve$

$Cu + H^+ \longrightarrow H_2\uparrow$ (acid)

$H^+ + e^- \rightarrow H_2\uparrow$ From metal

Q Why $E^{\circ}_{Cu^{2+}/Cu}$ has +ve Value.

$Cu_{(s)} \xrightarrow[+339]{\text{atomisation}} Cu_{(g)} \xrightarrow[+745]{I.E_1} Cu^{+} \xrightarrow[+1958]{I.E_2} Cu^{2+}_{(g)} \xrightarrow[-2121]{\text{(Hydration)}} Cu^{2+}_{(aq)}$

Endo (A) | $3d^{10}4s^1$ Endo (B) | $3d^{10}$ (C) Endo | EXO (D)

+1958
+745
+339
+3042

Main Reason

* High $I.E_2$ of Cu

D is not componsate by

B + C

~~$I.E_1 + I.E_2$~~

The stability of the half-filled d sub-shell in Mn^{2+} and the completely filled d^{10} configuration in Zn^{2+} are related to their E° values, whereas E° for Ni is related to the highest negative $\Delta_{hyd}H°$.

Hydration

(ii) $E^{\circ}_{M^{3+}/M^{2+}}$ (imp points)

(i) $E^{\circ}_{Sc^{3+}/Sc^{2+}}$ → Very Low value (very negative) → Sc^{3+} [Ar] $3d^0 4s^0$ → stable Inert gas configuration

(ii) $E^{\circ}_{Zn^{3+}/Zn^{2+}}$ → Very high value (+ve) → Zn^{2+} → d^{10} configuration

(iii) $E^{\circ}_{Mn^{3+}/Mn^{2+}}$ → High value (+ve) → Mn^{2+} d^5 configuration

(iv) $E^{\circ}_{Fe^{3+}/Fe^{2+}}$ → Positive but Very less positive (+0.77)

(v) $E^{\circ}_{V^{3+}/V^{2+}}$ → Negative (−0.26) (But very less negative)

$E^{o}_{M^{3+}/M^{2+}}$

$E^{o}_{Cr^{3+}/Cr^{2+}}$ = −ve

$E^{o}_{Fe^{3+}/Fe^{2+}}$ = +ve 0.77

$E^{o}_{Co^{3+}/Co^{2+}}$ = +ve 1.9

$E^{o}_{Mn^{3+}/Mn^{2+}}$ = +ve 1.59

Q.1 Which is stronger R.A Cr^{2+} or Fe^{2+}

$Cr^{+2} > Fe^{2+}$ (Reducing Power)

Q.2 Which is stronger O.A Mn^{3+} or Co^{3+}

$Mn^{3+} < Co^{3+}$ (Oxidising Power)

4.3.6 Trends in the M^{3+}/M^{2+} Standard Electrode Potentials

An examination of the $E°(M^{3+}/M^{2+})$ values (Table 4.2) shows the varying trends. The low value for Sc reflects the stability of Sc^{3+} which has a noble gas configuration. The highest value for Zn is due to the removal of an electron from the stable d^{10} configuration of Zn^{2+}. The comparatively high value for Mn shows that $Mn^{2+}(d^5)$ is particularly stable, whereas comparatively low value for Fe shows the extra stability of $Fe^{3+}(d^5)$. The comparatively low value for V is related to the stability of V^{2+} (half-filled t_{2g} level, Unit 5).

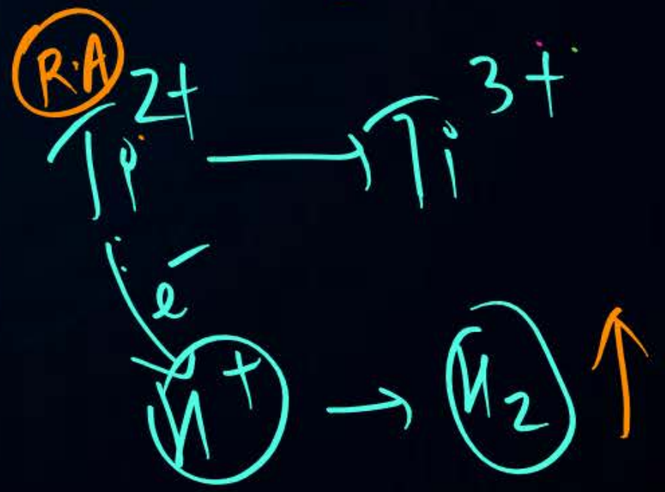
Chemical reactivity and $E^{\ominus}$ values

"Some Imp Points"

(1.) Co^{3+} & Mn^{3+} are oxidising agent. ✓

(2.) Ti^{2+}, V^{2+}, Cr^{2+} Reducing agent ✓
& Can librate H_2 gas From dilute Acids.

(3) Cu can not librate H_2 gas Fsom dil acids.
due to its $E^{0}_{Cu^{2+}/Cu}$ value.
+ve



(4.) Mn Zn & Ni have Low $E^{\circ}_{M^{2+}/M}$ Values than Expectation.

THANK YOU

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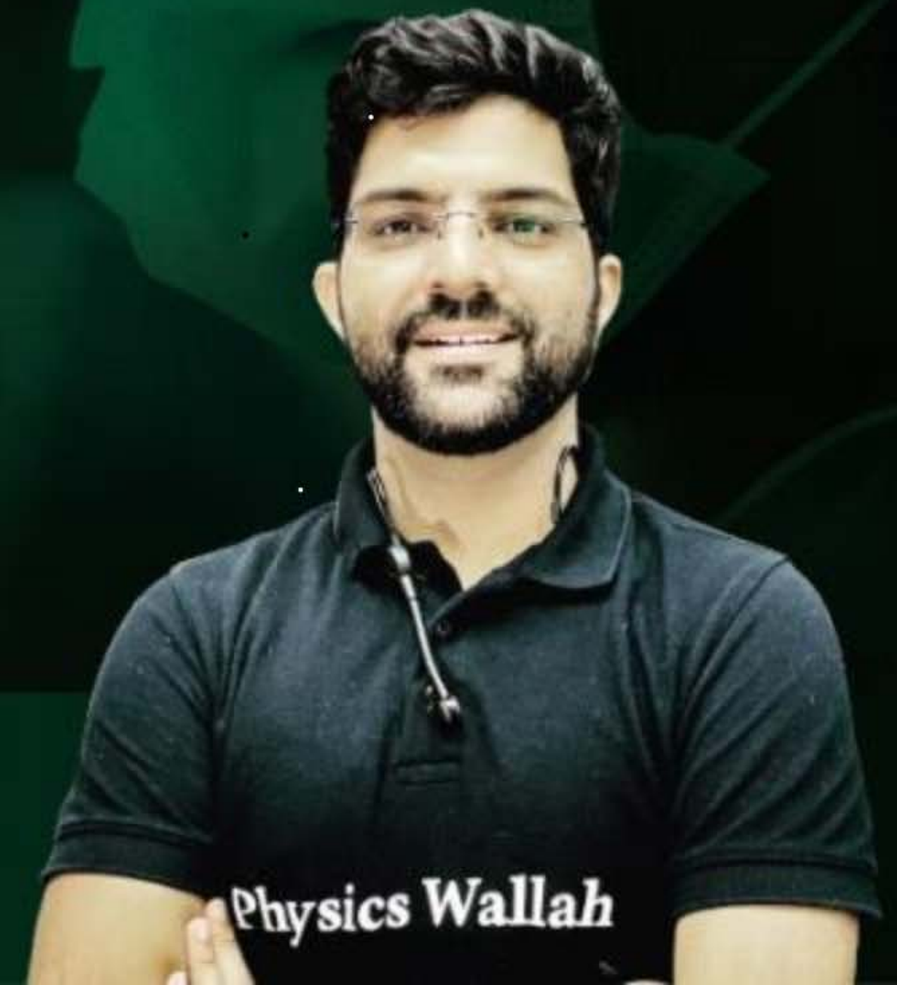
Lecture -03 | Inorganic Chemistry

The d and f-Block Elements

By - Mohit Dadheech (MD Sir)



Today's Goal :-

* Oxides of d-Block.
* $KMnO_4$ & $K_2Cr_2O_7$
* Imp Questions Related to $K_2Cr_2O_7$ & $KMnO_4$.

Important Oxides of d-Block Elements

Some Imp. Points :-

(i) All 3d series elements form $\overset{+2}{M}O$ type oxides (Except Sc) ~~ScO~~ ∵ Sc^{2+} ~~Exist~~

(ii) All $\overset{+2}{M}O$ type oxides are ionic in Nature. (+2 Low O.S Fajan Ka Ulta)

(iii) O.S ↑se Covalent character ↑se

Ionic ↓se.

$CrO < Cr_2O_3 < CrO_3$ (Covalent)

$MnO < MnO_2 < Mn_2O_7$

(iii) O.S ↑ E.N ↑ Acidic Nature of O^{2-} Ion ; Basic ↓.

(iv) O^{2-} in

+1, +2, +3 → Low O.S Basic in Nature

+4 → Amphoteric

+5, +6 +7, +8 → Acidic.

-gen

* Zn^{2+}, Cr^{3+} → Amphoteric

(v) V_2O_5 is Mainly acidic but Can show amphoteric Nature also :-

- with acid gives → VO_2^+
- with Alkalies (Base) gives → VO_4^{3-}

Ex $\overset{+3}{V_2O_3} < \overset{+4}{V_2O_4} < \overset{+5}{V_2O_5}$ (Acidic)

O.S ↑ E.N ↑ Acidic ↑

$V_2O_3 > V_2O_4 > V_2O_5$ (Basic)

Basic — less Basic — Ampho/Acidic.

$KMnO_4$ Potassium permanganate

$\overset{+7}{MnO_4^-}$ → Permanganate ion

$\overset{+6}{MnO_4^{2-}}$ Manganate ion.

* $\overset{+6}{MnO_4^{2-}} \xrightarrow{H^+} \overset{+7}{MnO_4^-} + \overset{+4}{MnO_2}$

dark green

Preparation of $KMnO_4$

(From MnO_2 → Pyrolusite ore)

MnO_2 —Oxidation. in Basic Medium (KOH)→ $K_2\overset{+6}{Mn}O_4$ (P. Manganate (dark green))

O.A → Air / KNO_3

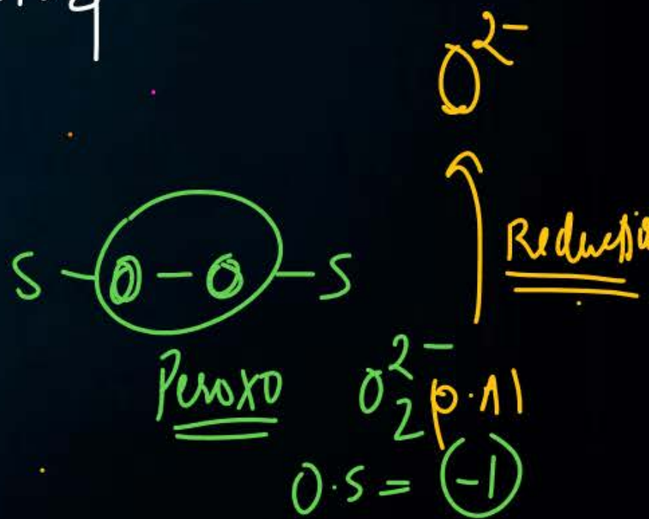
$K_2\overset{+6}{Mn}O_4$ —H^+→ $KMnO_4 + MnO_2$

$K_2\overset{+6}{Mn}O_4$ —Electrolysis→ $K\overset{+7}{Mn}O_4$

$K_2\overset{+6}{Mn}O_4$ —O_3 (Powerful O.A)→ $KMnO_4$

Laboratory Method

$$Mn^{2+} + \underset{(O.A)}{S_2O_8^{2-}} \longrightarrow \overset{+7}{MnO_4^-} + SO_4^{2-}$$



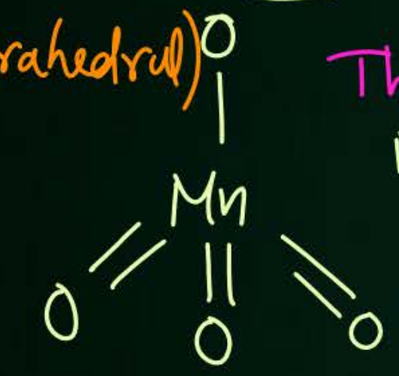
MnO_4^- : (+7) → d^0 diamagnetic

But can show Temp. dependent Paramagnetism.

Permanganate ion

dark purple/violet (Colour due to LMCT → Ligand to M charge transfer)

(Tetrahedral)



Three ($d\pi - p\pi$)

Mn — O

d — p(π)

Avg. Mn-O B.O = $\frac{7}{4}$

Avg. F.Con "O" = $-\frac{1}{4}$

All Mn-O B.L are equal.

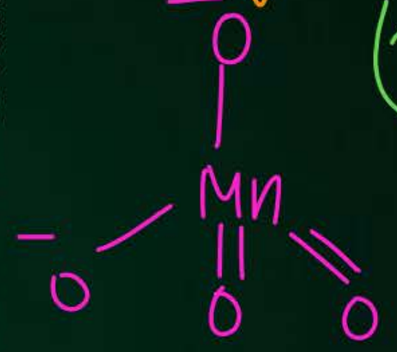
$MnO_4^- > MnO_4^{2-}$ (B.O)

$MnO_4^- < MnO_4^{2-}$ B.L

MnO_4^{2-} : (+6) → d^1 (n=1) Paramagnetic.

Manganate ion

dark green.



(Two $d\pi - p\pi$)

tetrahedral

Avg. Mn-O B.O → $\frac{6}{4}$

Avg. F.Con "O" → $\frac{-2}{4}$

All Mn-O B.L are equal due to resonance

Reactions of $KMnO_4$

(i) Thermal decomposition

$$\overset{+7}{KMnO_4(s)} \xrightarrow{\Delta} \overset{+6}{K_2MnO_4} + \overset{+4}{MnO_2} + O_2 \uparrow$$

(ii) Oxidising Reactions

$\overset{+7}{MnO_4^-}$ (O.A)

Mn^{+2}/Mn^{+4}

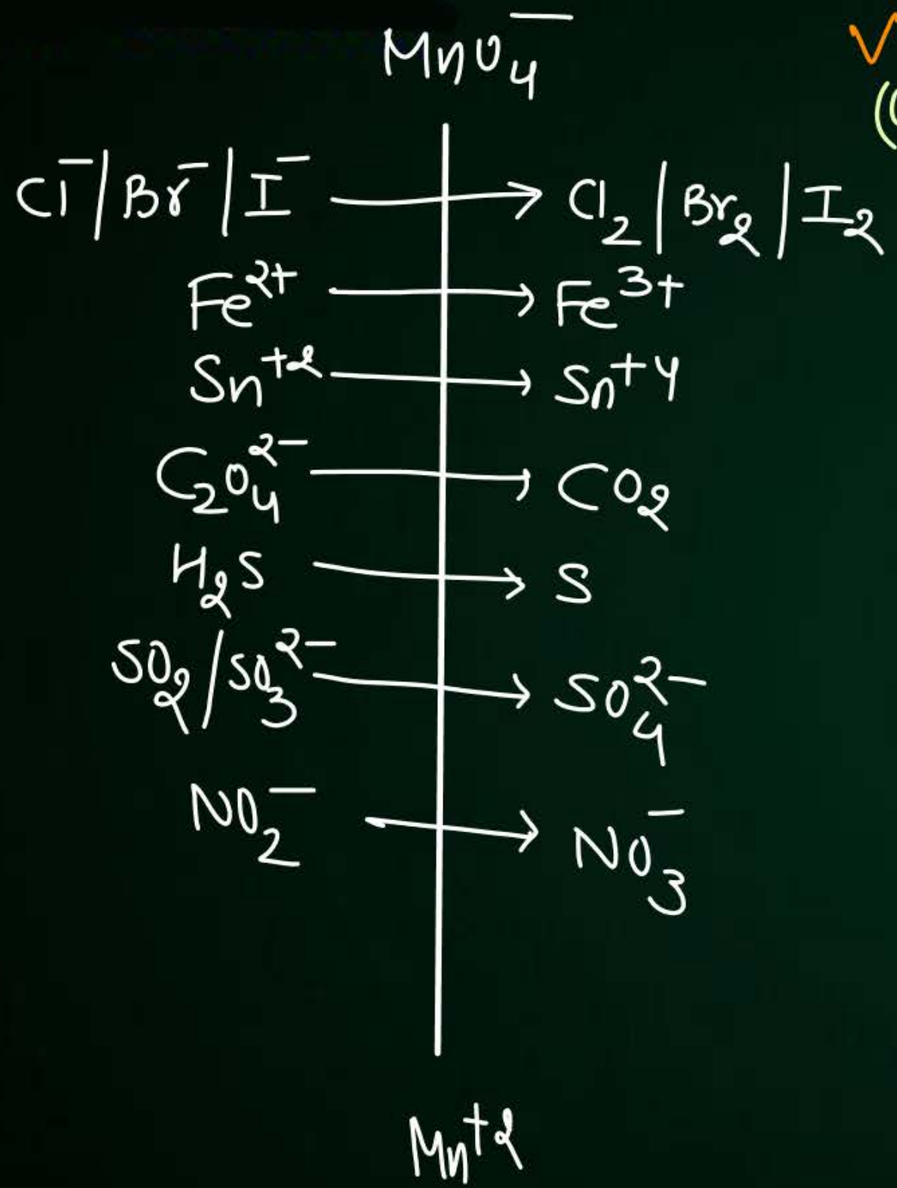
In $KMnO_4$ Mn Present in +7 (H.O.S) Can work as O.A in acidic as Well Weak Basic or neutral Medium.

(Faintly Basic)

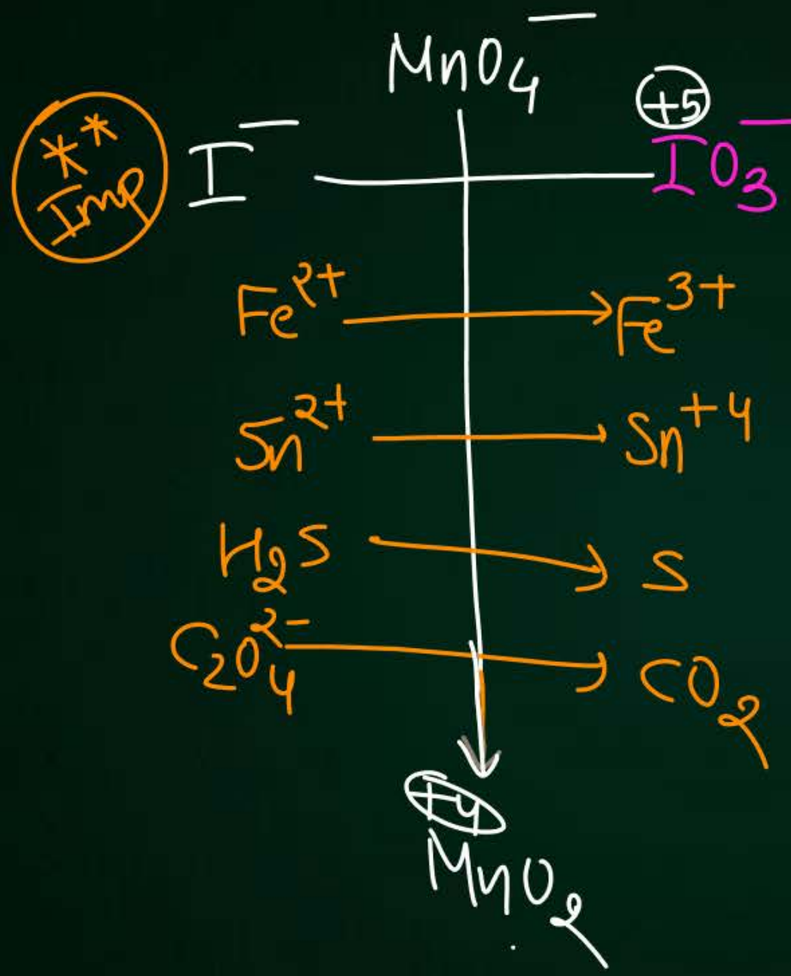
In Acidic Medium

$\overset{+7}{Mn}O_4^- \longrightarrow \overset{2+}{Mn}$

Violet (O.A) → Colourless



In neutral or weak Basic Medium



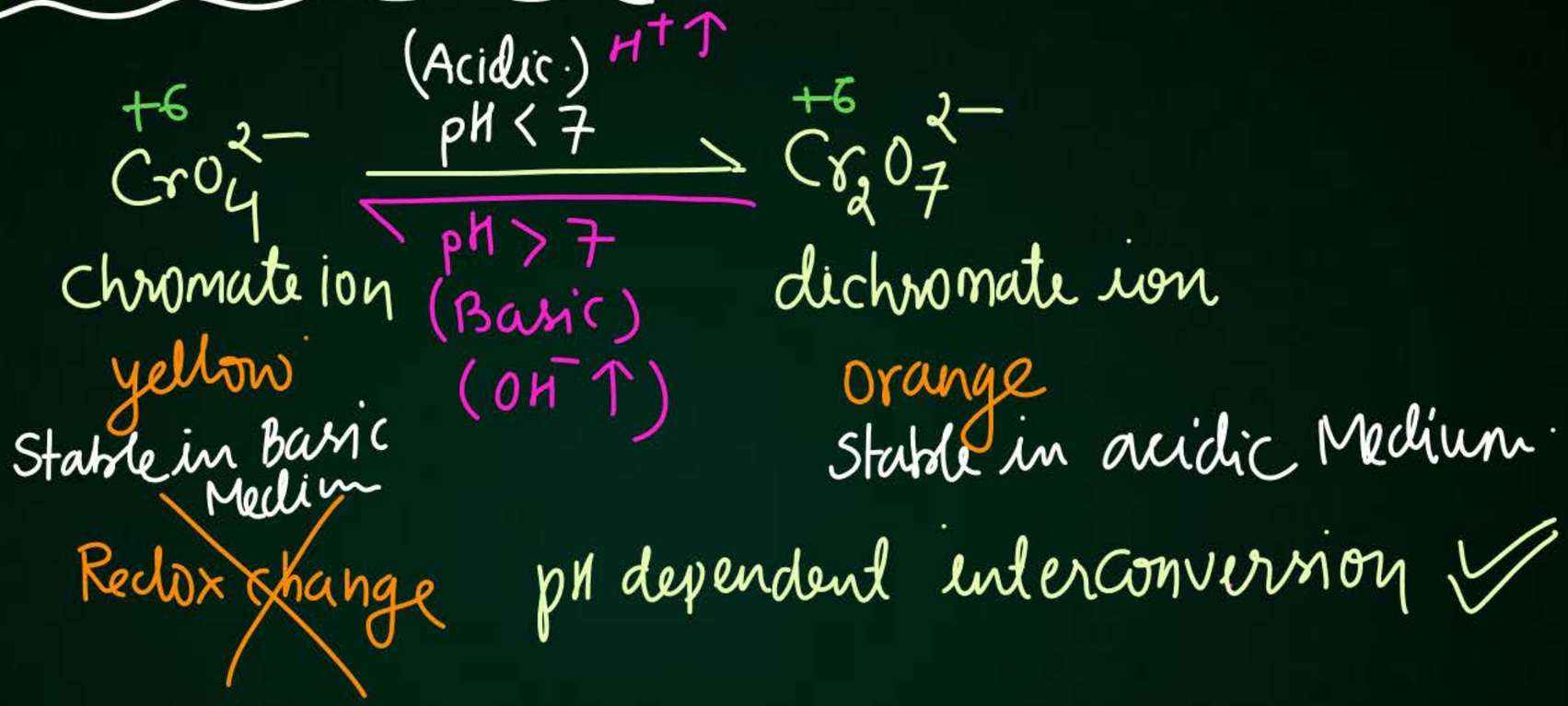
V.V.Imp

(-1)

$I^- + MnO_4^-$

- Acidic Medium → I_2 (0)
- Neutral or Weak Basic → IO_3^- (+5)

$K_2Cr_2O_7$ → Potassium dichromate



Preparation of $K_2Cr_2O_7$

By chromite ore $FeCr_2O_4$ ($FeO + Cr_2O_3$)

$FeCr_2O_4 \xrightarrow[(Air)]{\text{Oxidation}} Fe_2O_3 + CrO_3 \xrightarrow[(Basic)]{Na_2CO_3} Na_2CrO_4 \xrightarrow[(Conc.\ H_2SO_4)]{H^+} Na_2Cr_2O_7 \xrightarrow{KCl} K_2Cr_2O_7$

- $FeCr_2O_4$: $FeO \cdot Cr_2O_3$ (+2, +3)
- Fe_2O_3: Basic, +3
- CrO_3: Acidic, +6
- Na_2CrO_4: yellow solution
- $Na_2Cr_2O_7$: Orange soln.
- $K_2Cr_2O_7$: Orange crystals

NOTE (i) Solubility $K_2Cr_2O_7 < Na_2Cr_2O_7$.

(ii) $K_2Cr_2O_7$ is used as Primary standard.
(Preferred over $Na_2Cr_2O_7$)

Reason $Na_2Cr_2O_7$

Hygroscopic

In Nature

absorb Moisture From atmosphere.

Conc. change

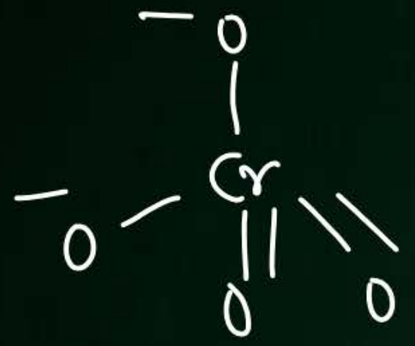
Primary ~~standard~~

$K_2Cr_2O_7$

Hygroscopic

Primary standard. ✓

CrO_4^{2-}



tetrahedral.

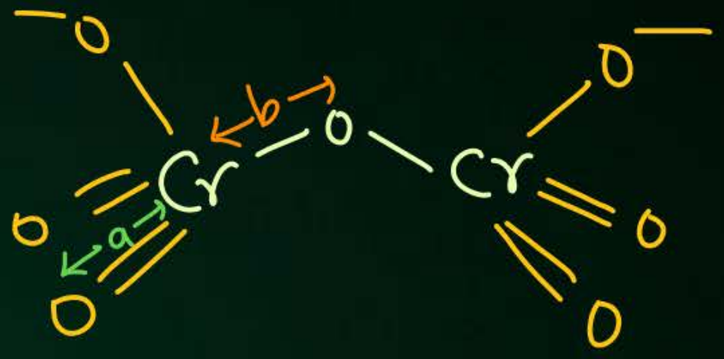
Two $d_\pi - p_\pi$

All Cr-O B.L are equal.

(Resonance)

avg Cr-O B.O $= \frac{6}{4}$

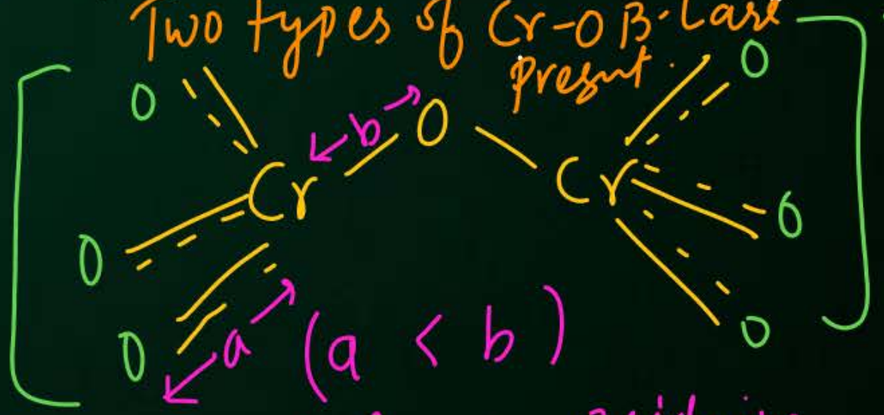
$Cr_2O_7^{2-}$ (Four $d_\pi - p_\pi$)



→ Two tetrahedra Units

→ All Cr-O B.L are not equal

Two types of Cr-O B.L are present



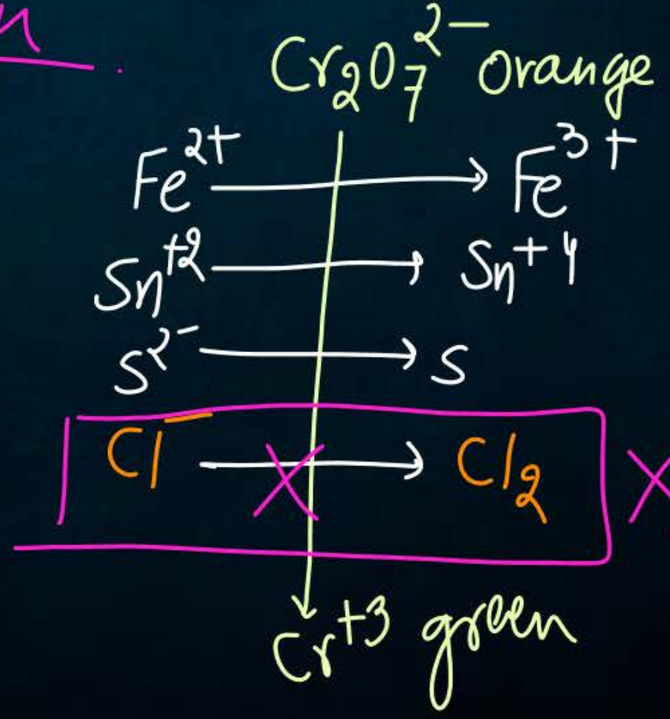
Terminal Cr-O B.L < Bridging Cr-O B.L

Reactions of $K_2Cr_2O_7$

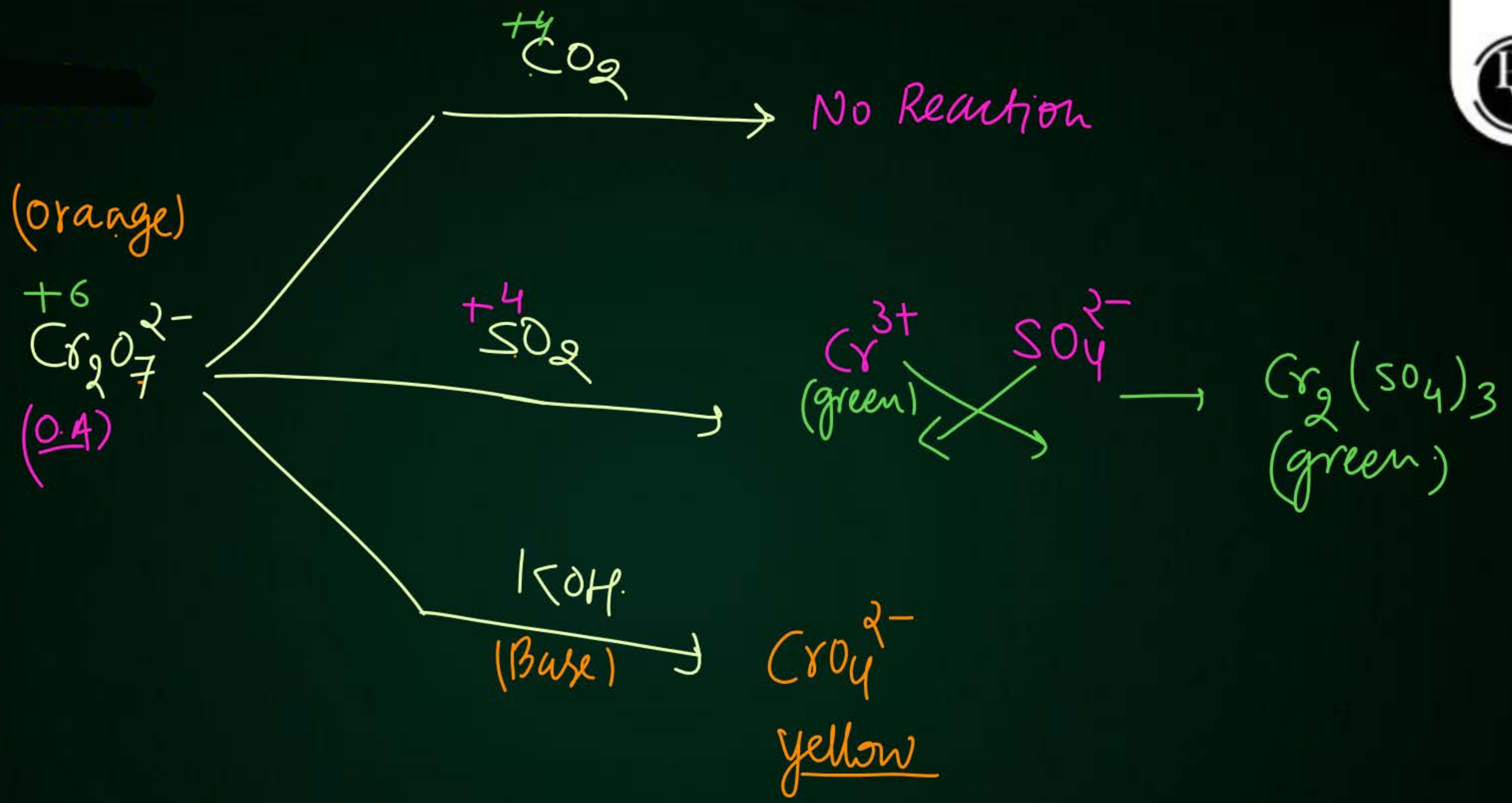
(i) Thermal decomposition

$$\overset{+6}{K_2Cr_2O_7}{}_{(s)} \xrightarrow{\Delta} K_2CrO_4 + \overset{+3}{Cr_2O_3} + O_2 \uparrow$$

(ii) Oxidising Reaction



$\because Cl_2 > Cr_2O_7^{2-}$ (O.A)


+4
CO2
No Reaction
(Orange)
+6
Cr2O7 2-
(0.4)
+4
SO2
Cr 3+
(green)
SO4 2-
Cr2(SO4)3
(green)
KOH
(Base)
CrO4 2-
yellow

QUESTION

MnO_4^- can not be decolourised by :

$(+7)\ MnO_4^- \longrightarrow Mn^{2+}$

1. CO_2 — C^{+4} ✗

2. SO_2 — $S^{+4} \longrightarrow S^{+6}$

3. FAS (Mohr's salt) — $Fe^{2+} \longrightarrow Fe^{3+}$

4. HCl — $Cl^- \longrightarrow Cl_2$

QUESTION

$$3MnO_4^{2-} + 2H_2O \rightarrow 2MnO_4^- + 4OH^- + MnO_2$$

To increase % yield of MnO_4^-, OH^- can be removed by help of :

1. HCl
2. KOH
3. SO_2
4. CO_2

QUESTION

$KMnO_4$ can be prepared from K_2MnO_4 as per the reaction

$$3MnO_4^{2} + 2H_2O \rightleftharpoons 2MnO_4^{-} + MnO_2 + 4OH^{-}$$

The reaction can go to completion by removing OH^- ions by addings :-

[NEET-UG 2013]

1. SO_2
2. HCl
3. KOH
4. CO_2

QUESTION

For titration of $KMnO_4$ with FAS in H^+ medium which of the following acid can be used ?

1. HCl, HBr, HI → $Cl_2/Br_2/I_2$

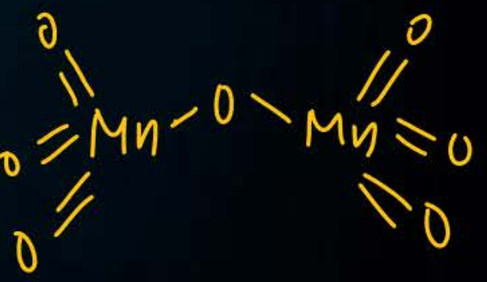
$$\underset{\text{(O.A)}}{MnO_4^-} + \underset{\text{(R.A.)}}{Fe^{2+}} \xrightarrow{H^+\text{medium}} Mn^{+2} + Fe^{3+}$$

2. HNO_3 → $\overset{+5}{N}O_3^- + Fe^{2+} \rightarrow Fe^{3+} + NO$

3. Dil.H_2SO_4

4. Conc. H_2SO_4

(dehydrating agent)



$$\overset{+7}{2KMnO_4} \xrightarrow[H^+]{\text{Conc.}H_2SO_4\ (\overset{+6}{})} \underset{\text{Permagnic acid}}{2\overset{+7}{H}MnO_4} \xrightarrow{-H_2O} \underset{\text{(oily, green, explosive)}}{Mn_2O_7}$$

Dil H_2SO_4 → Acidic ✓
dehydration X
oxidising X

Conc. H_2SO_4 → Acidic ✓
→ Oxidising ✓
→ dehydrating ✓

QUESTION

Reaction of $KMnO_4$ with $Na_2C_2O_4$ in H^+ medium becomes faster after some time, why ?

$$MnO_4^- + C_2O_4^{2-} \xrightarrow{H^+} \underset{\text{auto catalyst}}{Mn^{2+}} + CO_2$$

Ans Mn^{2+} work as Auto catalyst

QUESTION

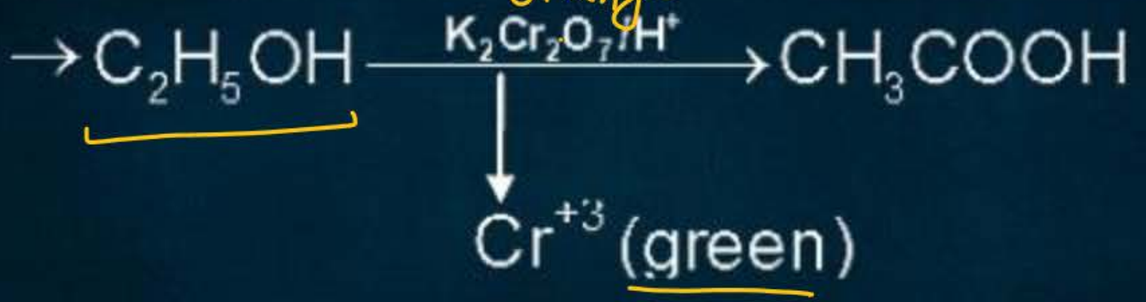
E°_{cell} of reaction of $KMnO_4$ with H_2O is +ve, even $KMnO_4$ can be used as analytical reagent with H_2O. How can you explain it ?

→ Because kinetically it is very slow reaction.

QUESTION

Write chemical reaction of drunken driven test ?

Orange



THANK YOU

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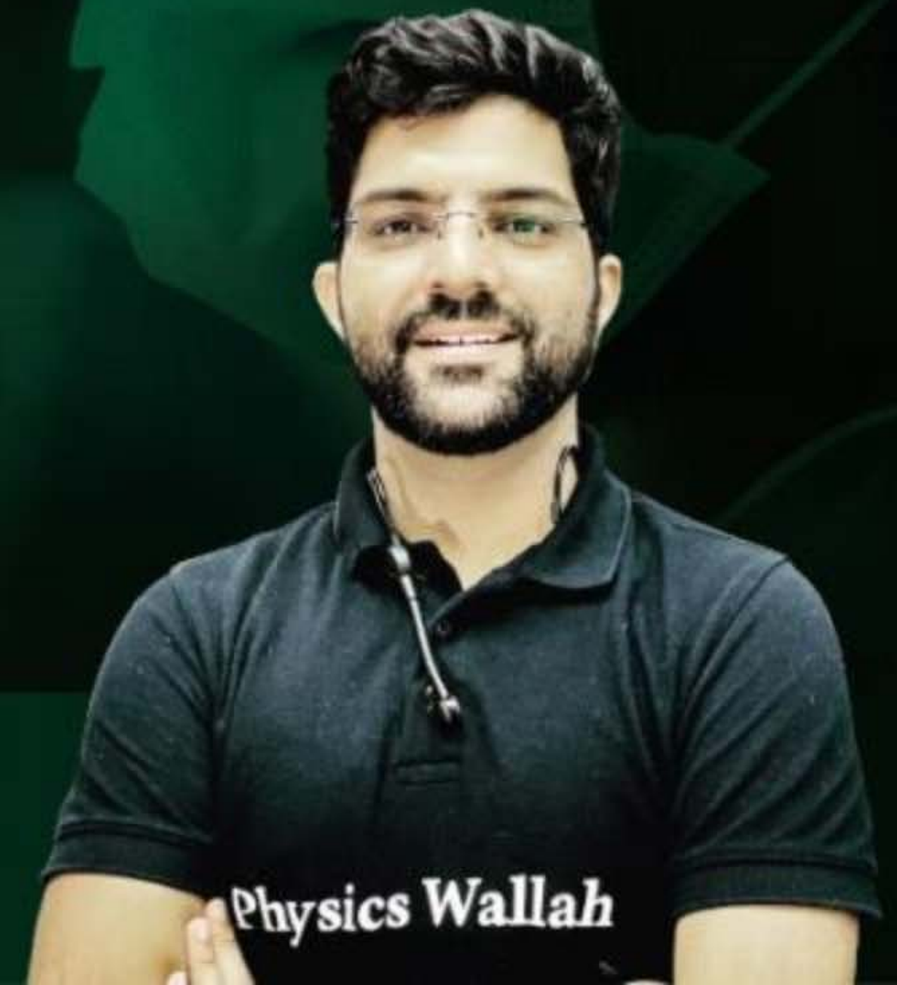
FOR NEET 2025

Lecture -04 Inorganic Chemistry

d & f Block Elements

By - Mohit Dadheech (MD Sir)



Topics *to be covered*

1. f-Block Elements.
2.

f Block Elements

(4f series)

Lanthanoids (Ln)

$n = 6$

group - 3

58 to 71

Ce to Lu

(5f series)

Actinoids

$n = 7$

group - 3

90 to 103

Th to Lr

Lanthanoids :-

① e⁻ Configuration

* $6s^2$ is Common but vairable occupancy of 4f subshell.
*

MDJ

① $5d^0$ Normal

$5d^1$ → Exceptional.

② Ab tak 56 Bharo.

$[Xe]\,6s^2$ Common in all (54 + 2 = 56)

③ Remaining e⁻ in 4f.

④ Ce Gd Lu → $5d^1$

Cinema Gadar Lut gayi

(58)	Ce	$[Xe]$	$6s^2\ 4f^1\ 5d^1$
59	Pr	$[Xe]$	$6s^2\ 4f^3\ 5d^0$
60	Nd	$[Xe]$	$6s^2\ 4f^4\ 5d^0$
61	Pm	$[Xe]$	$6s^2\ 4f^5\ 5d^0$
62	Sm	$[Xe]$	$6s^2\ 4f^6\ 5d^0$
63	Eu	$[Xe]$	$6s^2\ 4f^7\ 5d^0$
64	Gd	$[Xe]$	$6s^2\ 4f^7\ 5d^1$
65	Tb	$[Xe]$	$6s^2\ 4f^9\ 5d^0$
66	Dy	$[Xe]$	$6s^2\ 4f^{10}\ 5d^0$
67	Ho	$[Xe]$	$6s^2\ 4f^{11}\ 5d^0$
68	Er	$[Xe]$	$6s^2\ 4f^{12}\ 5d^0$
69	Tm	$[Xe]$	$6s^2\ 4f^{13}\ 5d^0$
70	Yb	$[Xe]$	$6s^2\ 4f^{14}\ 5d^0$
71	Lu	$[Xe]$	$6s^2\ 4f^{14}\ 5d^1$

MDJ

f^0, f^2, f^8 XX

f^7, f^{14} Repeats

$[Xe]\ 4f\ 5d\ 6s^2$

Energy → 6s < 4f < 5d

② Size

Left to right decreases due to increase in Z_{eff} → due to Lanthanoid Contraction or.

$L \rightarrow R$ e^- are filled into 4f subshell.

Which have poor σ, $\sigma \downarrow$ $Z_{eff} \uparrow$

Contraction in Size occours (Lanthanoid Contraction)

Eu > La > Ce > Pr > Nd > Pm > Sm < Eu > Gd > Tb > Dy > Ho > Er > Tm > Yb > Lu

f^7 loose packing

weak Metal-Metal Bonding

$\gamma \uparrow$ Size $\uparrow$

Size in M^{+3}

$La^{3+} > Ce^{3+} > Pr^{3+} > Nd^{3+} > Pm^{3+} > Sm^{3+} > Eu^{3+} > Gd^{3+} > Tb^{3+} > Dy^{3+} > Ho^{3+} > Er^{3+} > Tm^{3+} > Yb^{3+} > Lu^{3+}$

Reason → Same

Lanthanoid contraction (due to poor shielding effect of 4f-e⁻)

NOTE

$La(OH)_3$ ---------- $Lu(OH)_3$

Size ↓ EN ↑ Acidic Nature ↑se Basic ↓se

of OH^-/O^{2-}

(3) Oxidation states

* Common O.S state → +3 ✓
* Most stable O.S is +3 ✓
* Some elements also show **+2 & +4**
* Some elements due to Vacant, Half filled (f^7), Full filled (f^{14}) f stability

Ce

$[Xe]\ 4f^1\ 5d^1\ 6s^2$ → $1e^-$, $1e^-$, $2e^-$

Ce^{+4}

$[Xe]\ 4f^0\ 5d^0\ 6s^0$

Inertgas Or Vacant f

Ex

Ce^{+4} $4f^0$ (inertgas) $[Xe]\ 4f^0\ 5d^0\ 6s^0$

Tb^{+4} $4f^7$ → Halffilled stable

Yb^{+2} $4f^{14}$ Full filled stable

Eu^{+2} $4f^7$ Half filled stable.

$Ce^{+4} \longrightarrow Ce^{+3}$ $E^{\circ} = +1.74$

$Tb^{+4} \longrightarrow Tb^{+3}$

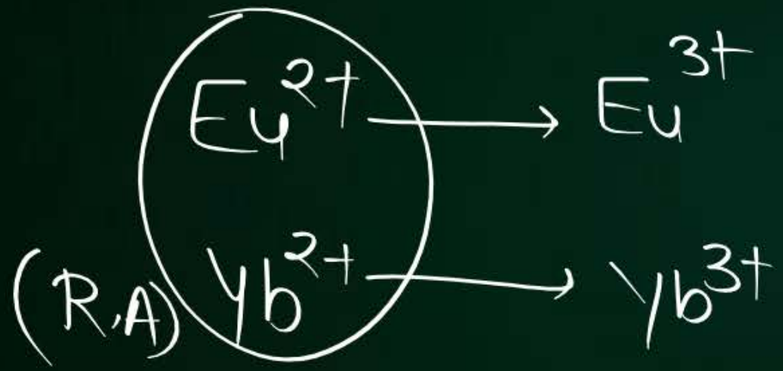
(O.A)

Work as oxidant.

0·5 0·5

$+4 \longrightarrow +3$

(O.A)



$Eu^{2+} \longrightarrow Eu^{3+}$

$Yb^{2+} \longrightarrow Yb^{3+}$

(R.A)

$+2 \longrightarrow +3$

Reductant

(4) Gen. Characteristics :-

* Silvery White Metals
* Tarnish Rapidly in air
* Hardness ↑ L → R (Sm → steel Hard)
* good Conductors of Heat & electricity. 1623 K MP
* almost all trivalent (M^{3+}) ions are Coloured in Both solid & aq. But La^{3+}, Lu^{3+} Colourless
* f^0 & f^{14} type Lanthanoids are diamagnetic.

f^0 f^{14} f^0 f^{14}
La^{3+}, Lu^{3+}, Ce^{+4}, Yb^{+2}

⇒ Restare Paramagnetic (no. of unpaired e^- present)

I.E → $I.E_1$ & $I.E_2$ of lanthanoids. Similar to Ca

600 & 1200 ($KJmol^{-1}$)

→ Abnormal Low value of $I.E_3$ ⇒ La, Gd, Lu

HIT

Reason → after removal of 3rd e^- ($I.E_3$) these three species achive empty, Half filled & full filled f orbital stability respectively

La $[Xe]\,4f^0\,5d^1\,6s^2$	Gd $[Xe]\,4f^7\,5d^1\,6s^2$	Lu $[Xe]\,4f^{14}\,5d^1\,6s^2$
$\downarrow$	$\downarrow$	$\downarrow -3e^-$
$La^{3+}\,[Xe]\,4f^0$	$Gd^{3+}\,[Xe]\,4f^7$	$Lu^{3+}\,4f^{14}$

Chemical Reactivity :-

Earlier members reactivity → Similar to Ca.

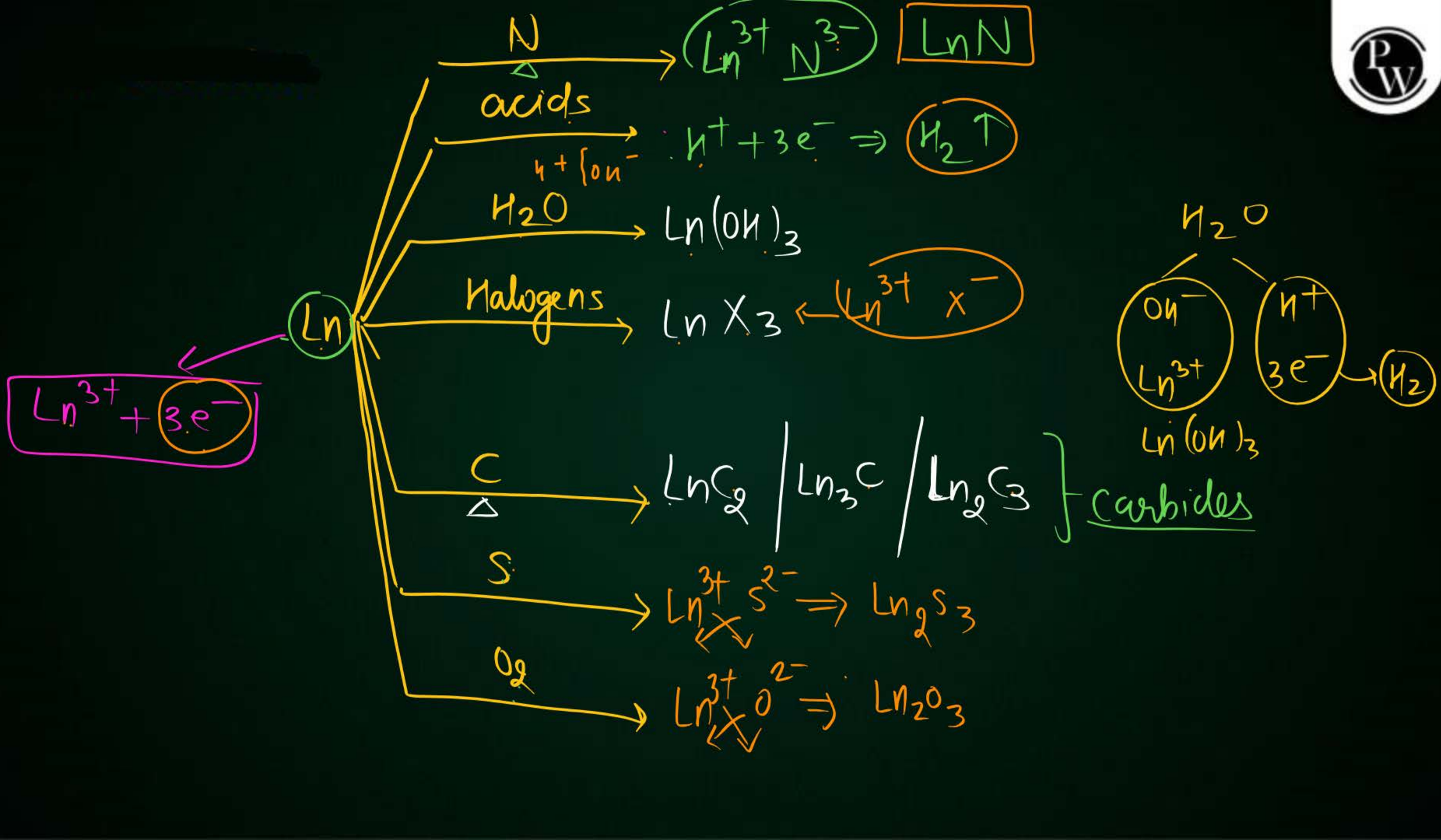
with ↑se in atomic no. they behave like Al

$$Ln^{3+}_{(aq)} + 3e^- \longrightarrow Ln_{(s)} \Rightarrow \left(E^{\ominus} = -2.2 \text{ to } -2.4\,V\right)$$

Ln

↓

Common Symbol For All Lanthanoids

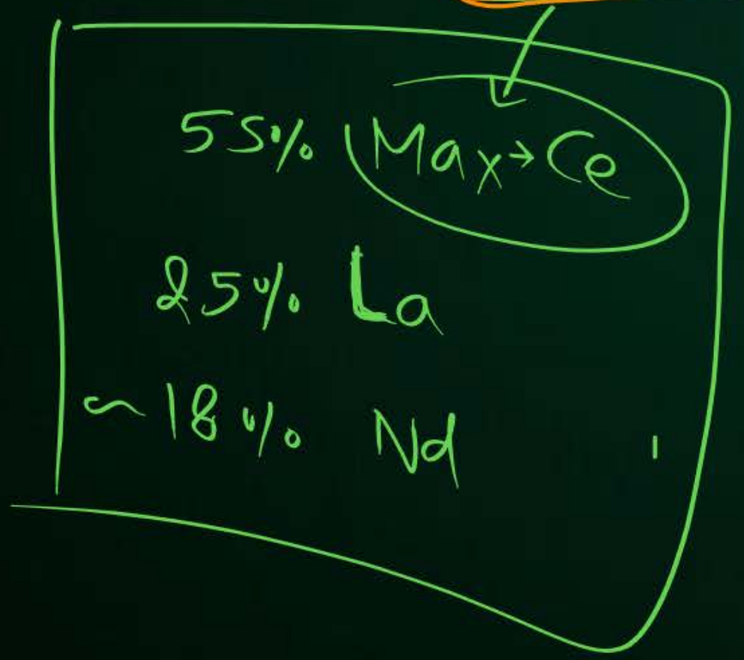

N
Ln^{3+} N^{3-}
LnN
acids
$4+[OH^-]$
$H^+ + 3e^- \Rightarrow H_2\uparrow$
H_2O
$Ln(OH)_3$
Halogens
LnX_3
Ln^{3+} X^-
Ln
$Ln^{3+} + 3e^-$
C
LnC_2 | Ln_3C | Ln_2C_3
carbides
S
Ln^{3+} $S^{2-} \Rightarrow Ln_2S_3$
O_2
Ln^{3+} $O^{2-} \Rightarrow Ln_2O_3$
H_2O
OH^-
Ln^{3+}
$Ln(OH)_3$
H^+
$3e^-$
H_2

Uses

→ In the production of alloy steels (Plates & Pipes → (Pipes))

→ Mischmetall

95% Ln + 5% Fe & traces of S, C, Ca, Al



Actinoids :-

* Radioactive elements
* earlier members have relatively long Half-lives
  the latter one have a day to 3 minutes For Lr (103)

Electronic Configuration :-

* 5f Subshell is Progressively filled
* $7s^2$ is common in all.

MDJ

⇒ Ab tak 88 fill karo.

$Rn + 7s^2$
$86 + 2 = 88$

⇒ Remaining e^- 5f Mai fill karo.

Note → Th 90 = $6d^2$

$6d^0$ → normal

$6d^{1/2}$ exceptional.

91 92 93 96 103 ⇒ $6d^1$
Pa U Np Cm Lr

90	Th	[Rn]	$7s^2$
91	Pa		
92	U		
93	Np		
94	Pu		
95	Am		
96	Cm		
97	Bk		
98	Cf		
99	Es		
100	Fm		
101	Md		
102	No		
103	Lr	[Rn]	$7s^2$

86

88

Same.

Same

$5f^0$	$6d^2$
$5f^2$	$6d^1$
$5f^3$	$6d^1$
$5f^4$	$6d^1$
$5f^6$	$6d^0$
$5f^7$	$6d^0$
$5f^7$	$6d^1$
$5f^9$	$6d^0$
$5f^{10}$	$6d^0$
$5f^{11}$	$6d^0$
$5f^{12}$	$6d^0$
$5f^{13}$	$6d^0$
$5f^{14}$	$6d^0$
$5f^{14}$	$6d^1$

f^1, f^5, f^8 XX

f^7, f^{14} Repeats

Size :- gen. ↓se $L \to R$ in "M" as well "M^{3+}"

due to actinoid: Contraction.

↓

due to poor σ of 5f e^-

$Z_{eff} = Z - \sigma$

$\sigma \downarrow$ Z_{eff} ↑

Shielding order

$s > p > d > f$

↓

$4f > 5f$

Contraction strength → A.C > L.C

↓

Contraction due to more poor σ of 5f e^-

Contraction due to poor σ of 4f e^-

Oxidation states :-

* Common +3 but show Variable O.S. due to Comparable energy levels of | 7s, 5f, 6d | subshell. (Low Energy diff)

Other imp points :-

* Max. O.S ⇒ +7 (Np & Pu)

→ gen. I.E are lesser than lanthanoids.

→ Size greater than Ln.

→ Highly Reactive in Powdered form.

→ gen. All | actinoids + conc. HNO_3 | → Passivation

Formation of Protective oxide layer on Metal surface

NCERT Solved and Unsolved Intext Questions

QUESTION

On what ground can you say that scandium (Z = 21) is a transition element but zinc (Z = 30) is not?

Sol. On the basis of incompletely filled 3d orbitals in case of scandium atom in its ground state ($3d^1$), it is regarded as a transition element. On the other hand, zinc atom has completely filled d orbitals ($3d^{10}$) in its ground state as well as in its oxidised state, hence it is not regarded as a transition element.

Sc → $3d^1 4s^2$

T.E

QUESTION

Q Why do T.E Exhibit higher Atomisation enthalpi

Sol. Because of large number of unpaired electrons in their atoms they have stronger interatomic interaction and hence stronger bonding between atoms resulting in higher enthalpies of atomisation.

QUESTION

In the series Sc (Z = 21) to Zn (Z = 30), the enthalpy of atomisation of zinc is the lowest, i.e., 126 kJ mol^{-1}. Why?

Ans

Sc ⟶ Zn

- d^1 . d^{10}
- d^1 to d^5 n ↑
- d^5 to d^{10} n ↓

Zn d^{10}

n = 0

All e^- are paired in (n-1)d.

Weak metal-metal Bond.

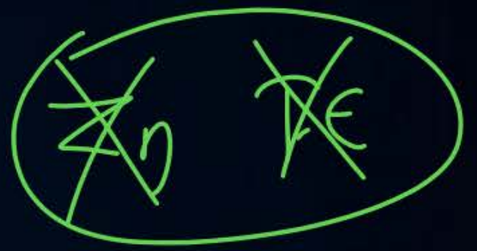
Atomization Enthalpy ↓

QUESTION

Name a transition element which does not exhibit variable oxidation states.

Sol. Scandium (Z = 21) does not exhibit variable oxidation states.

only Sc^{3+} ✓



QUESTION

Which of the 3d series of the transition metals exhibits the largest number of oxidation states and why?

Ans → Mn

$3d^5$ 5 Unpaired in (n-1)d.

$3d^5 4s^2$

X Y

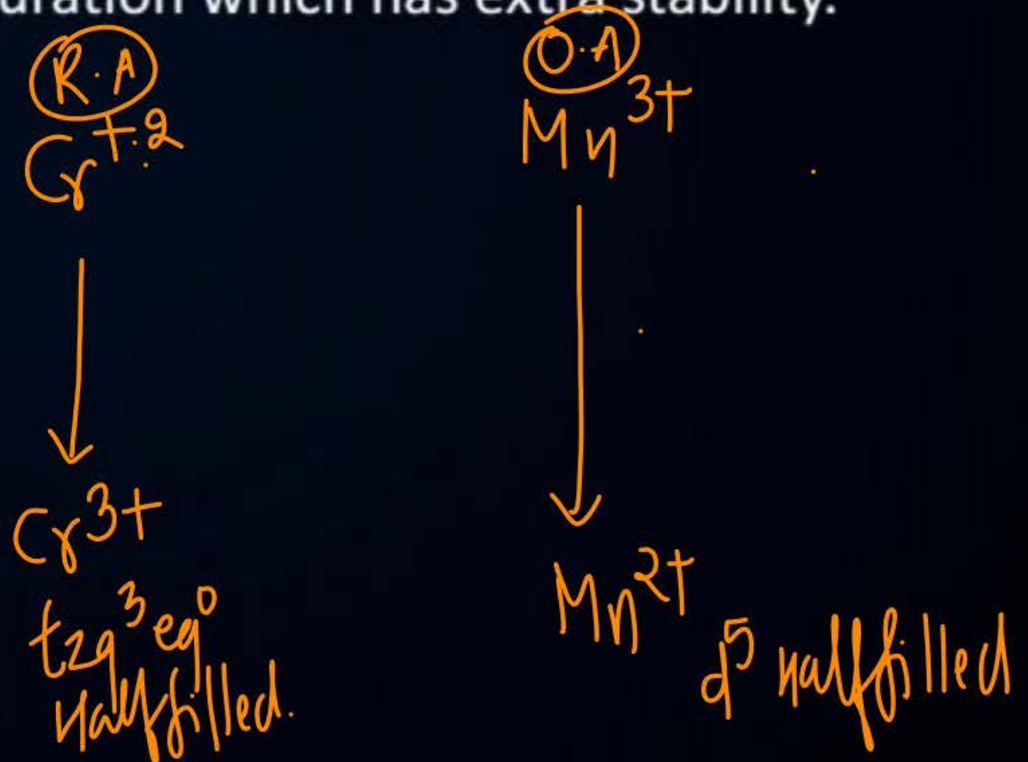
Mn^{2+} to Mn^{+7}

y to x+y

QUESTION

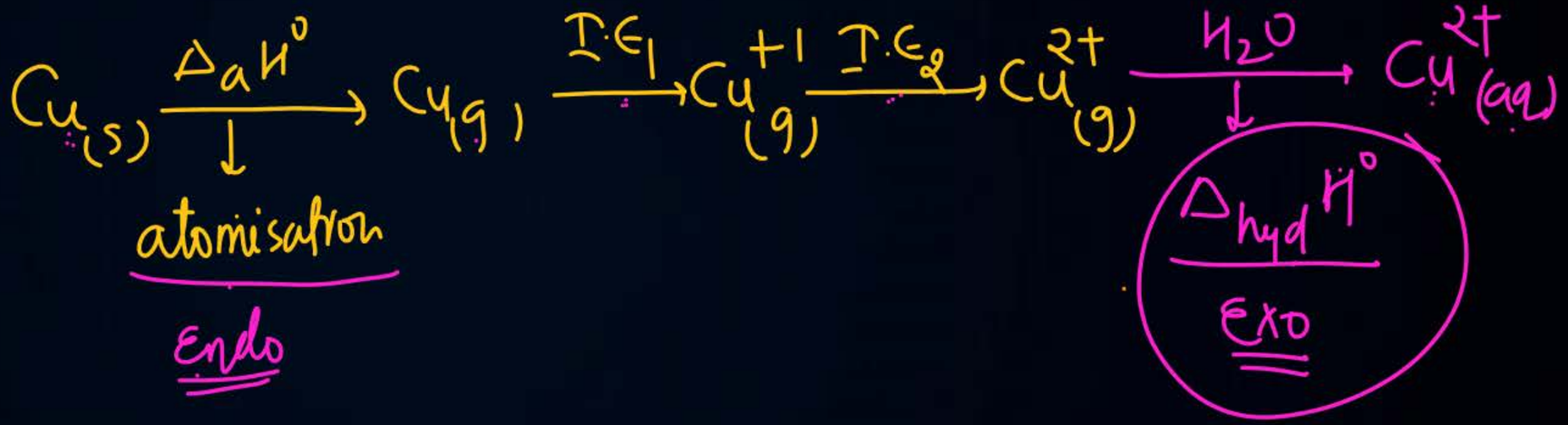
Why is Cr^{2+} reducing and Mn3+ oxidising when both have d^4 configuration?

Sol. Cr^{2+} is reducing as its configuration changes from d^4 to d^3, the latter having a half-filled t_{2g} level (see Unit 5). On the other hand, the change from Mn^{3+} to Mn^{2+} results in the half-filled (d^5) configuration which has extra stability.



QUESTION

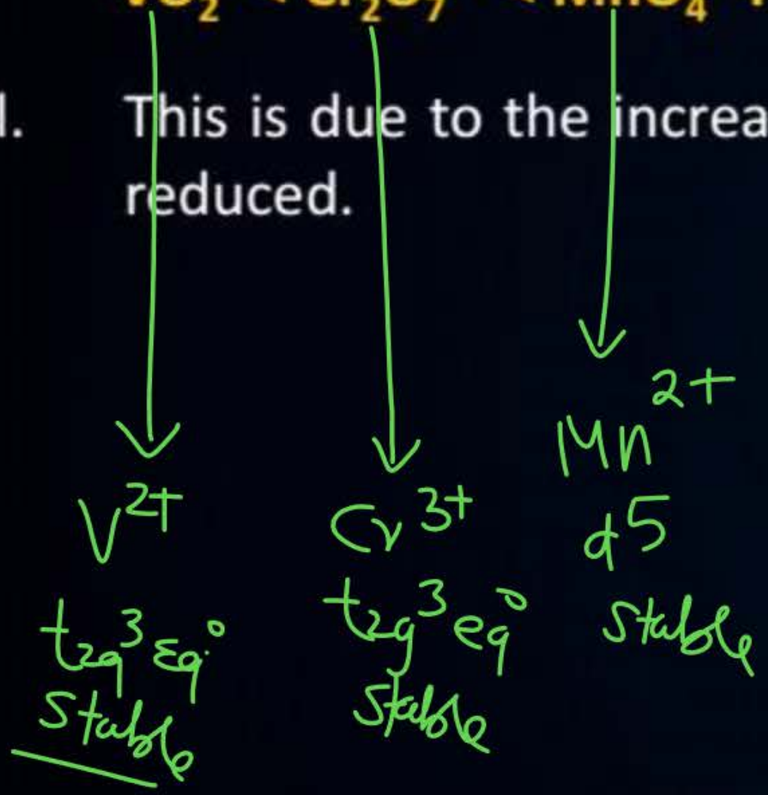
The $E^0(M^{2+}/M)$ value for copper is positive (+0.34V). What is possible reason for this? (Hint: consider its high $\Delta_a H^\circ$ and low $\Delta_{hyd} H^\circ$)



QUESTION

How would you account for the increasing oxidising power in the series $VO_2^+ < Cr_2O_7^{2-} < MnO_4^-$?

Sol. This is due to the increasing stability of the lower species to which they are reduced.



QUESTION

How would you account for the irregular variation of ionisation enthalpies (first and second) in the first series of the transition elements?

Cr Mn (IE$_2$)

Cu Zn (I.E$_2$

QUESTION

For the first row transition metals the E° values are:

E°	V	Cr	Mn	Fe	Co	Ni	Cu
(M^{2+}/M)	–1.18	–0.91	–1.18	–0.44	–0.28	–0.25	–0.34

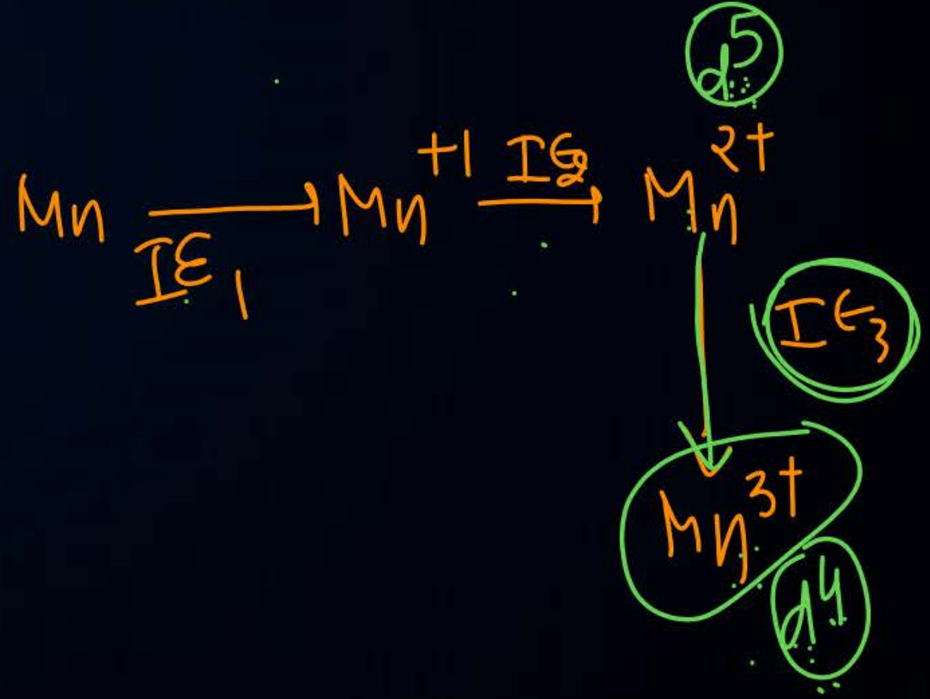
Explain the irregularity in the above values.

Sol. The $E°(M^{2+}/M)$ values are not regular which can be explained from the irregular variation of ionisation enthalpies $(\Delta_i H_1 + \Delta_i H_2)$ and also the sublimation enthalpies which are relatively much less for manganese and vanadium.

QUESTION

Why is the E° value for the Mn^{3+}/Mn^{2+} couple much more positive than that for Cr^{3+}/Cr^{2+} or Fe^{3+}/Fe^{2+}? Explain.

Sol. Much larger third ionisation energy of Mn (where the required change is d^5 to d^4) is mainly responsible for this. This also explains why the +3 state of Mn is of little importance.



QUESTION

Why is the highest oxidation state of a metal exhibited in its oxide or fluoride only?

due to High EN of O & F

QUESTION

Which is a stronger reducing agent Cr^{2+} or Fe^{2+} and why ?

NOTES

H.W

QUESTION

Calculate the magnetic moment of a divalent ion in aqueous solution if its atomic number is 25.

$Mn^{2+} \rightarrow (d^5)$ 5.....

Sol. With atomic number 25, the divalent ion in aqueous solution will have d^5 configuration (five unpaired electrons). The magnetic moment, μ is

$$\mu = \sqrt{5(5+2)} = 5.92 \text{ BM}$$

QUESTION

Calculate the 'spin only' magnetic moment of $M^{2+}_{(aq)}$ ion (Z = 27).

$Co^{2+} \rightarrow d^7$

$n = 3$

$\mu = 3.\ldots$

QUESTION

What is meant by 'disproportionation' of an oxidation state? Give an example.

Sol. When a particular oxidation state becomes less stable relative to other oxidation states, one lower, one higher, it is said to undergo disproportionation. For example, manganese (VI) becomes unstable relative to manganese(VII) and manganese (IV) in acidic solution.

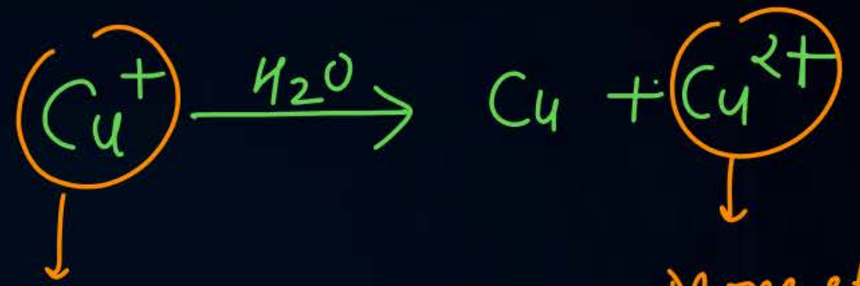
$3Mn^{VI}O_4^{2-} + 4H^+ \rightarrow 2Mn^{VII}O_4^- + Mn^{IV}O_2 + 2H_2O$

$MnO_4^{2-} \xrightarrow{H^+} MnO_4^- + MnO_2$

$Cu^+ + H_2O \longrightarrow Cu + Cu^{2+}$

QUESTION

Explain why Cu^{+} ion is not stable in aqueous solutions?



QUESTION

Name a member of the lanthanoid series which is well known to exhibit +4 oxidation state.

Sol. Cerium (Z = 58)

Ce^{+4}

O.A

QUESTION

Actinoid contraction is greater from element to element than lanthanoid contraction. Why?

due to more poor σ of 5f in actinoids Z_{eff} ↑se as compare to Lanthanoids

THANK YOU

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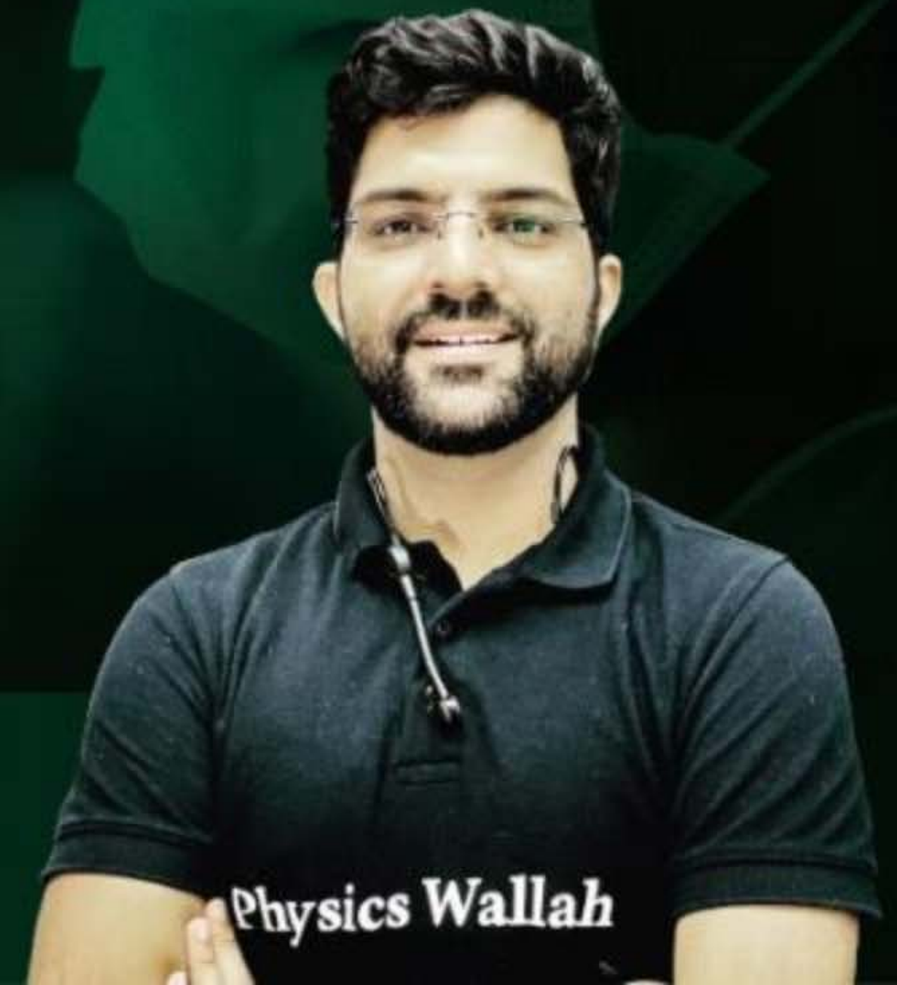
FOR NEET 2025

Lecture -01 | Inorganic Chemistry

The p-Block Elements



By - Mohit Dadheech (MD Sir)

Topics *to be covered*

1. Introduction
2. Inert pair effect & Atomic & Physical properties
3. Back-Bonding

NEET syllabus of p Block

UNIT 10: P- BLOCK ELEMENTS

Group -13 to Group 18 Elements

General Introduction: Electronic configuration and general trends in physical and chemical properties of elements across the periods and down the groups; unique behaviour of the first element in each group.

Introduction

"Elements in which last e^- enters into "p"-subshell"

p-subshell → 3 set of orbitals

np^{1-6}

Maximum 6 e^- can be accomodate thats why there are total 6 groups are present in p-Block.

13th to 18th

Electronic configurations

Outer gen. electronic configuration $\Rightarrow \boxed{ns^2\ np^{1-6}}$

Except He $1s^2$

$n=1$	s		
$n=2$	$2s$	$2p$	$[He]\ 2s^2\ 2p^{1-6}$
$n=3$	$3s$	$3p$	$[Ne]\ 3s^2\ 3p^{1-6}$
$n=4$	$4s \rightarrow$	$3d \rightarrow 4p$	$[Ar]\ 3d^{10}\ 4s^2\ 4p^{1-6}$
$n=5$	$5s$	$4d\ 5p$	$[Kr]\ 4d^{10}\ 5s^2\ 5p^{1-6}$
$n=6$	$6s$	$4f\ 5d\ 6p$	$[Xe]\ 4f^{14}\ 5d^{10}\ 6s^2\ 6p^{1-6}$

($4s^2$, $5s^2$, $6s^2$ are n^{th})

On moving down the group

d & f e^- involvement ↑se

which affect physical & Chemical properties in heavier members of some p-block elements

Inert Pair effect.

In heavier members of p-Block Inability of ns $\bar{e}$ pair (ns^2) to participate or towards any chemical reaction is known as Inert pair effect.

In Heavier members Nucleus is Heavy but shielding is poor. thats why Z_{eff} ↑se

Reason

n=2

Involvement of d & f-e^- ↑se. which Increase. attraction on ns. electron & make them. Inert. for any Chemical Reaction

n=6

⊕ $(n-2)f^{14}$ $(n-1)d^{10}$ (ns^2) np^{1-6}

$(n-2)f^{14}$ $(n-1)d^{10}$ → r↓ Z_{eff}↑

(ns^2) → attraction ↑se

13th	14th	15th	16th	17th	18th
ns^2np^1	ns^2np^2	ns^2np^3	ns^2np^4	ns^2np^5	$1s^2$ (He) ns^2np^6
B [He] $2s^2 2p^1$	C ... $2p^2$	N .. $3p^3$	O .. $2p^4$	F .. $2p^5$	Ne .. $2p^6$
Al [Ne] $3s^2 3p^1$	Si .. $3p^2$	P $3p^3$	S $3p^4$	Cl ... $3p^5$	Ar ... $3p^6$
Ga [Ar] $3d^{10} 4s^2 4p^1$	Ge ... $4p^2$	As $4p^3$	Se $4p^4$	Br ... $4p^5$	Kr ... $4p^6$
In [Kr] $4d^{10} 5s^2 5p^1$	Sn ... $5p^2$	Sb $5p^3$	Te $5p^4$	I ... $5p^5$	Xe ... $5p^6$
Tl [Xe] $4f^{14} 5d^{10} 6s^2 6p^1$	Pb ... $6p^2$	Bi $6p^3$	Po $6p^4$	At ... $6p^5$	Rn ... $6p^6$

s → f → d → p

Inert pair effect

#MDJ

d & f-e⁻ ↑se

Inert pair effect ↑

L·O·S stability ↑se

H·O·S stability ↓se

* due to Inert pair effect group O·S in heavier members reduced by 2 Unit

group O·S / H·O·S = $ns^2 + np$ e⁻

Ex $ns^2 np^3$ 2+3 = (+5)

Lower O·S = g.O·S / H·O·S − 2

Ex $(ns^2)np^3$ (inert) +5−2 = (+3)

(−2) due to inert pair effect.

(ns^2)

Find Correct order of H.O.S & L.O.S stability in Following :-

(1) $B^{+3} > Al^{3+} > Ga^{3+} > In^{3+} > Tl^{3+}$

(2) $N^{+5} > P^{+5} > As^{+5} > Sb^{+5} > Bi^{+5}$

(3) $C^{+2} < Si^{+2} < Ge^{2+} < Sn^{2+} < Pb^{2+}$

(4) $B^{+1} < Al^{+1} < Ga^{+1} < In^{+1} < Tl^{+1}$

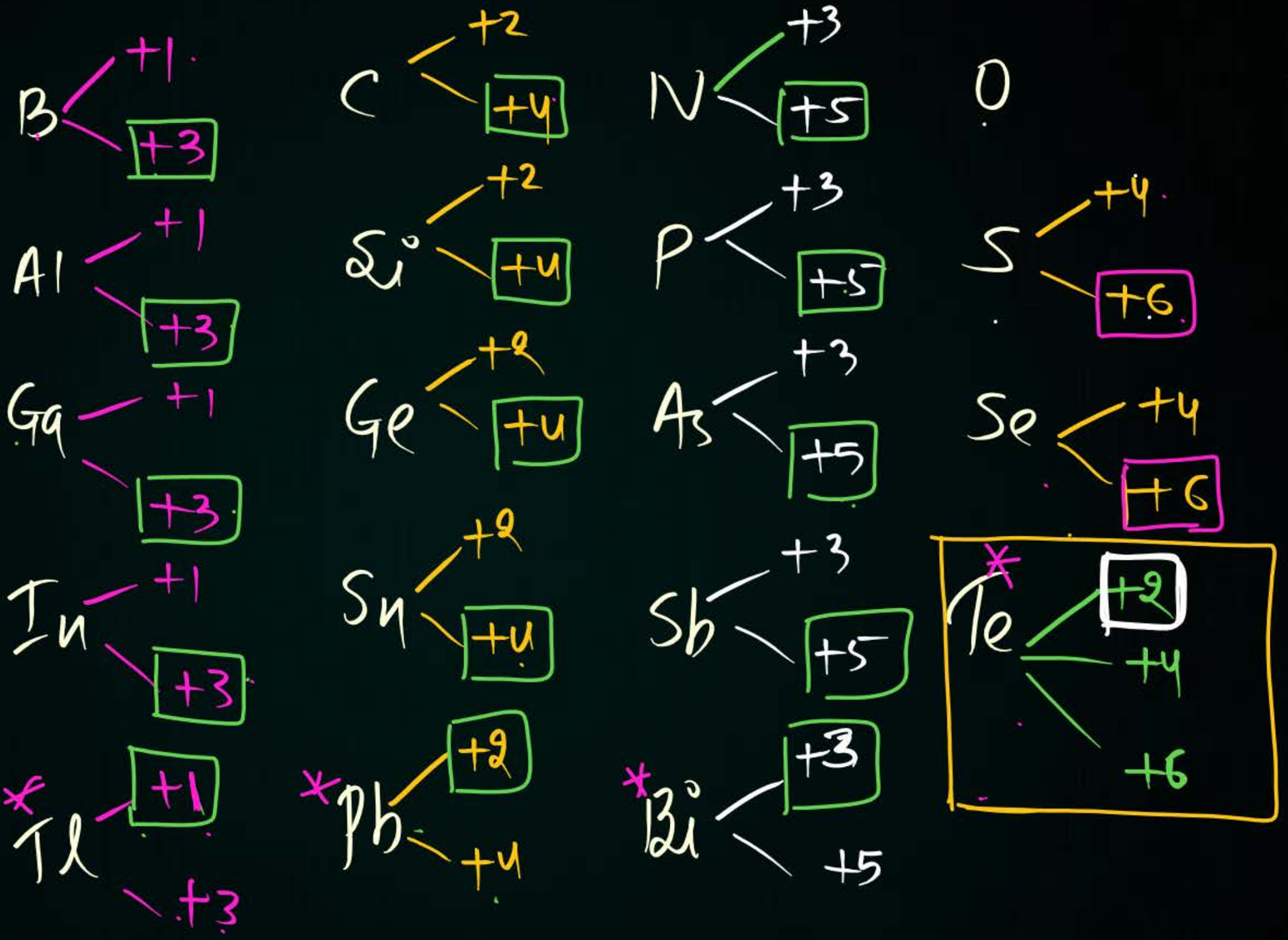
(5) $C^{+4} > Si^{+4} > Ge^{+4} > Sn^{+4} > Pb^{+4}$

(6) $N^{3+} < P^{3+} < As^{3+} < Sb^{3+} < Bi^{3+}$

13^{th} ns^2np^1 < +3 H.O.S, +1 L.O.S

14^{th} ns^2np^2 < +4 H.O.S, +2 L.O.S

15^{th} ns^2np^3 < +5 H.O.S, +3 L.O.S


B
+1
+3
Al
+1
+3
Ga
+1
+3
In
+1
+3
*Tl
+1
+3
C
+2
+4
Si
+2
+4
Ge
+2
+4
Sn
+2
+4
*Pb
+2
+4
N
+3
+5
P
+3
+5
As
+3
+5
Sb
+3
+5
*Bi
+3
+5
O
S
+4
+6
Se
+4
+6
*Te
+2
+4
+6

True/False

$Pb^{+4} \rightarrow Pb^{2+}$
(O.A)

(1) PbO_2, Pb_2O_3, Pb_3O_4 all are oxidising agent (T)

PbO_2 ($+4$)

Pb_2O_3 ($PbO + PbO_2$, PbO_2: $+4$, O.A)

Pb_3O_4 ($2PbO + PbO_2$, PbO_2: O.A)

(2) PbI_4 does not exist (T)

$Pb^{+4} \xleftarrow{e^-} I^-$ (Pb^{+4}: O.A, I^-: R.A) $\Rightarrow Pb^{+2} + I_2$

$Pb^{+2} + I^- \rightarrow PbI_2$

(3) TlI_3 does not exist as Tl^{3+} & $3I^-$ (T)

(Tl^{3+}: O.A, I^-: R.A)

(4) Sn^{+2} ions are good oxidising agent (F)

$Sn^{2+} \rightarrow Sn^{+4}$
R.A

(5) CO_2 & SO_2 are good oxidising agent (F)

$S^{+4} \rightarrow S^{+6}$
(R.A)

⑥ SO_2 is a good R.A while TeO_2 is an O.A. (T)

$S^{+4} \longrightarrow S^{+6}$
R.A

$Te^{+4} \longrightarrow Te^{+2}$
O.A

⑦ $SnCl_2$ & $FeCl_3$ Can not Exist together.. (T)

$Sn^{2+} \xrightarrow{e^-} Sn^{+4}$ (R.A)
$Fe^{3+} \longrightarrow Fe^{2+}$ (yellow → green)

$SnCl_2 + FeCl_3 \longrightarrow SnCl_4 + FeCl_2$
yellow → green

⑧ Stability of dihalides ↑se down the group in 14th group. (T)

EX_2 $\quad CX_2^{+2} < SiX_2^{+2} < GeX_2^{+2} < SnX_2^{+2} < PbX_2^{+2}$

PHYSICAL PROPERTIES

Final I.E

B > Tl > Ga > Al > In

SIZE

Top to Bottom

↑se (14th to 18th) group

group 13

B
↓
Al
↓
Ga → due to Transition Contraction.
↓
In
↓ due to 10 3d e⁻ poor
Tl

I.E

T → B

↓se (15th to 18th)

13th	14th
B	C
↓	↓
Al	Si
↓	↓
Ga	Ge
↓	↓
In	Sn
Tl	Pb

T.C ← Ga

L.C due to poor ⁻ve

M.P & B.P

B.P 13th, 14th ↓se

15th to 18th ↑se

* Sb > Bi * Te > Po

M.P (max) 1 > 2 > 3 > 4 > 5 (min)

1	2	5	4	3
B	Al	Ga	In	Tl

1	2	3	5	4
C	Si	Ge	Sn	Pb

5	4	1	2	3
N	P	As	Sb	Bi

1	2	3	5	4
O	S	Se	Te	Po

17th & 18th ↑se

Density

↑se (T → B)

* C diamond
↓
Si

E.N.

B	C	N	O	F
2.0	2.5	3.0	3.5	4.0

Al	Si
1.5	1.8
Ga	Ge
1.6	1.8
In	Sn
1.7	1.8
Tl	Pb
1.8	1.9

↓se ↓se ↓se

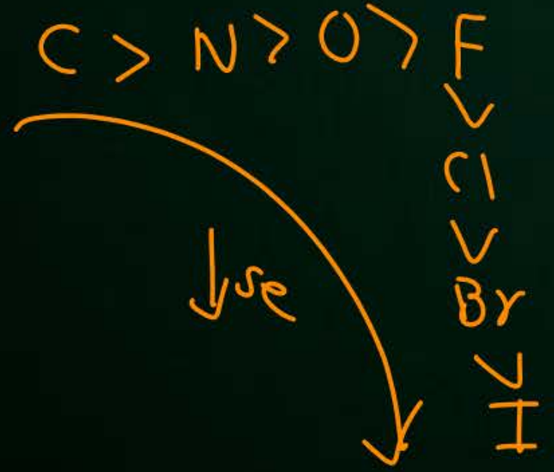
Back Bonding

π Coordinate Back Bonding.

Back-Bond

* π-Coordinate Bond. (π-Dative Bond)
* Special case of Resonance
* Temp. Bond (weak Bond)
* Formed between "adjacent Covalent Bonded atoms in which one should be belongs to 2nd period.
* For formation of π-Coordinate one atom. Should have Vacant orbital & Another should have l.p.

donation strength.



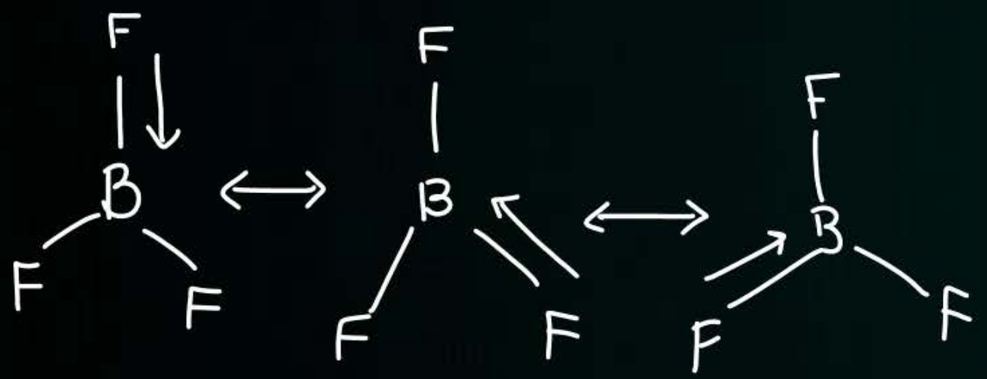
Back Bonding in BF_3

(B) $1s^2 2s^2 2p^1$

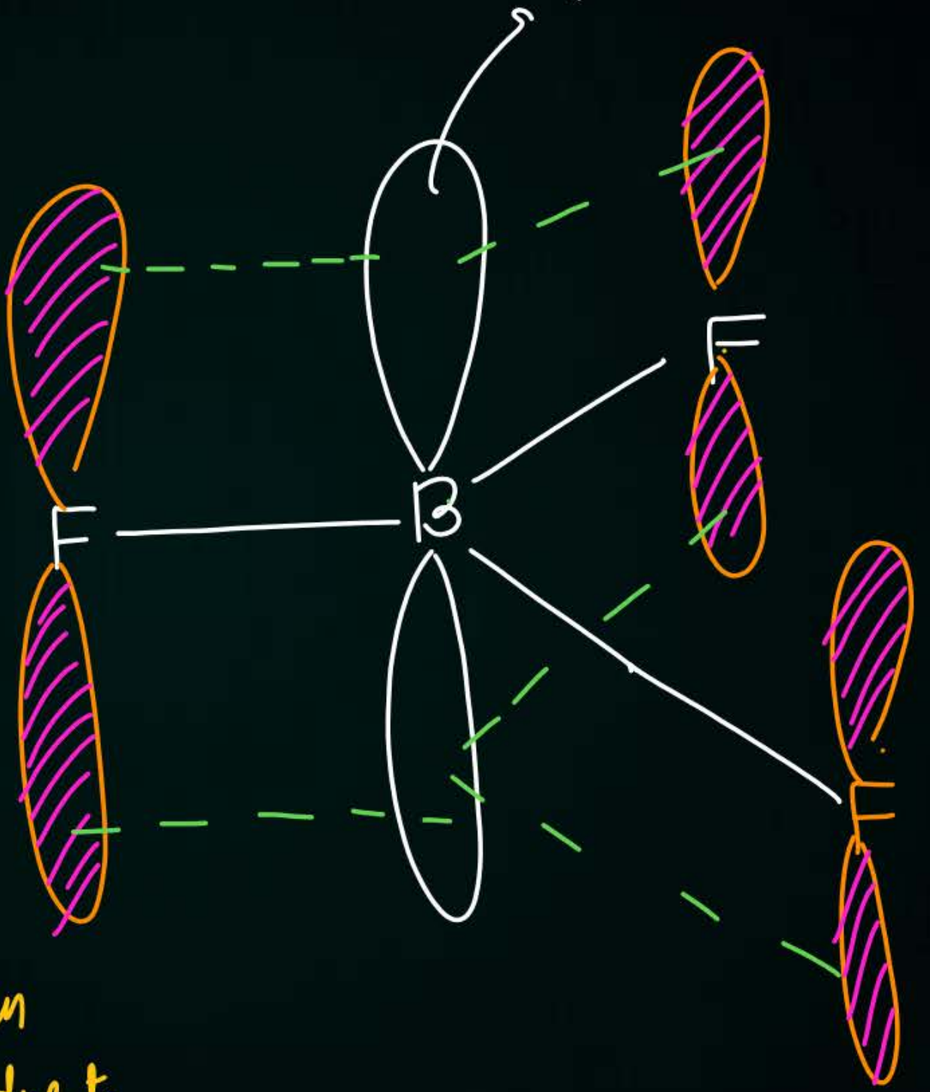
$B_{E.S.I}$ → 1 | 1 1 1 (P)

L L L

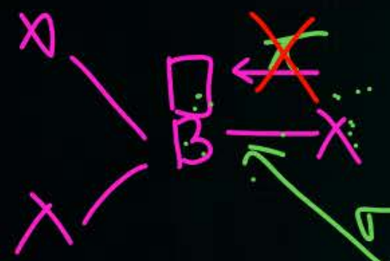
F F F



B–F B.L Shorter than Expectation due to Partial double Bond character (Resonance)



Strength of B·B in BX_3



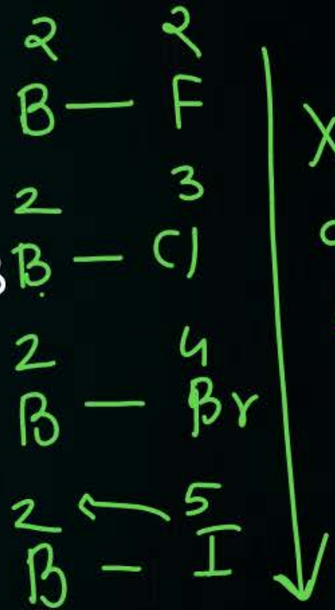
$BF_3 > BCl_3 > BBr_3 > BI_3$

e⁻ Rich like NH_3 species

Lewis acidic Character

$BF_3 < BCl_3 < BBr_3 < BI_3$

accepting l·p from other species



X^- size ↑ donation strength ↓

B·B Strength ↓se

THANK YOU

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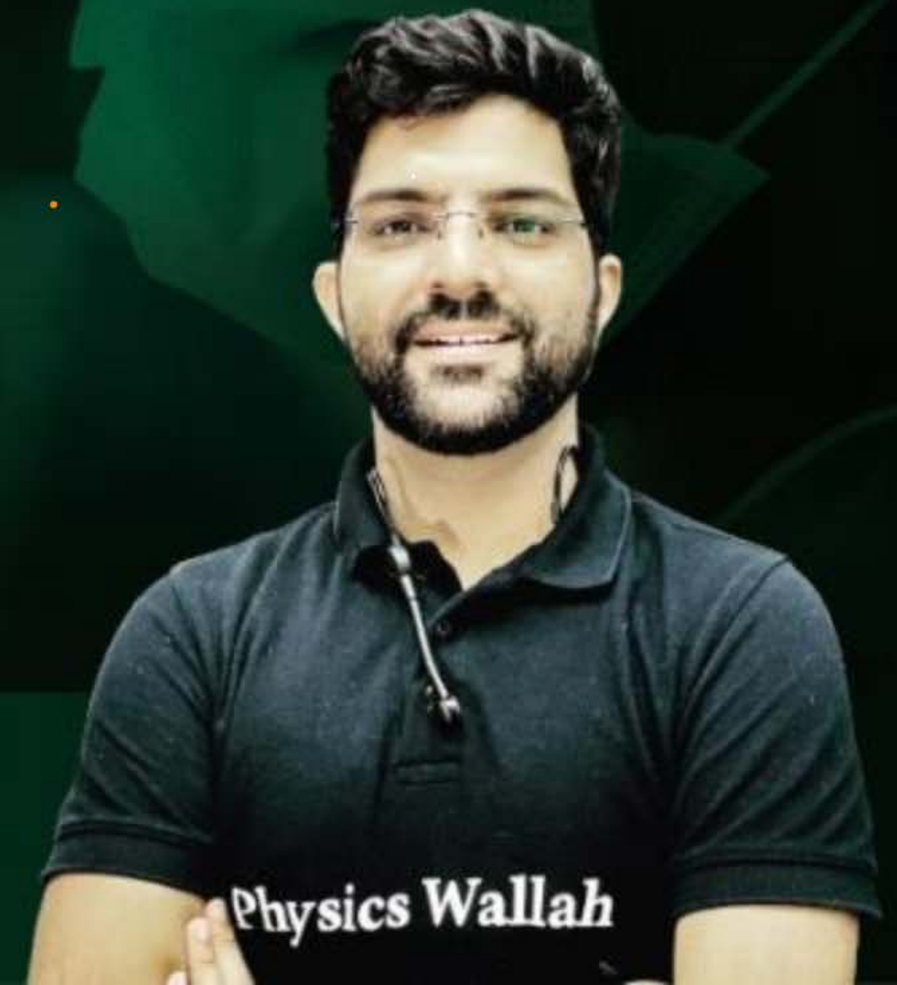
FOR NEET 2025

Lecture - 02 | Inorganic Chemistry

The p-Block Elements



By - Mohit Dadheech (MD Sir)

Topics *to be covered*

1. group 13th, 14th.
2.
3.

PHYSICAL PROPERTIES

Final I.E

B > Tl > Ga > Al > In

SIZE

Top to Bottom

↑se (14th to 18th) group

group 13

B
↓
Al
↓
Ga → due to Transition Contraction.
↓
In
↓ due to 10 3d
Tl e⁻ poor

I.E

T → 13

↓se (15th to 18th)

13th	14th
B	C
↓	↓
Al	Si
↓	↓
Ga	Ge
↓	↓
In	Sn
Tl	Pb

T.C ← Ga

L.C due to poor σ of e⁻

M.P & B.P

B.P 13th, 14th ↓se

15th to 18th ↑se

* Sb > Bi * * Te > Po

M.P (max) 1 > 2 > 3 > 4 > 5 (min)

1	2	5	4	3
B	Al	Ga	In	Tl

1	2	3	5	4
C	Si	Ge	Sn	Pb

5	4	1	2	3
N	P	As	Sb	Bi

5	4	3	1	2
O	S	Se	Te	Po

17th & 18th ↑se

Density

↑se T → B

* C diamond
↓
Si

E.N.

B	C	N	O	F
2.0	2.5	3.0	3.5	4.0

Al	Si
1.5	1.8
Ga	Ge
1.6	1.8
In	Sn
1.7	1.8
Tl	Pb
1.8	1.9

↓se ↓se ↓se

O < S < Se < Po < Te

NEET syllabus of p Block

UNIT 10: P- BLOCK ELEMENTS

Group -13 to Group 18 Elements

General Introduction: Electronic configuration and general trends in physical and chemical properties of elements across the periods and down the groups; unique behaviour of the first element in each group.

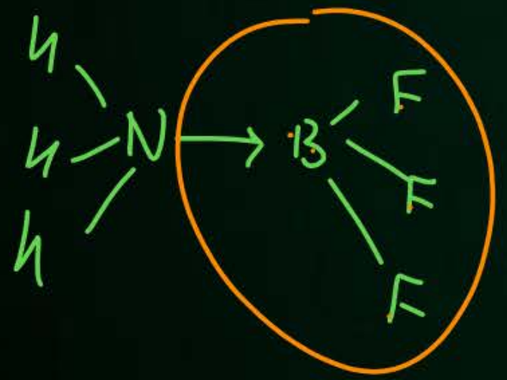
Back Bonding

B–F Bond length order.

① $BF_3 < BF_4^-$

② $BF_3 < NH_3 \cdot BF_3$

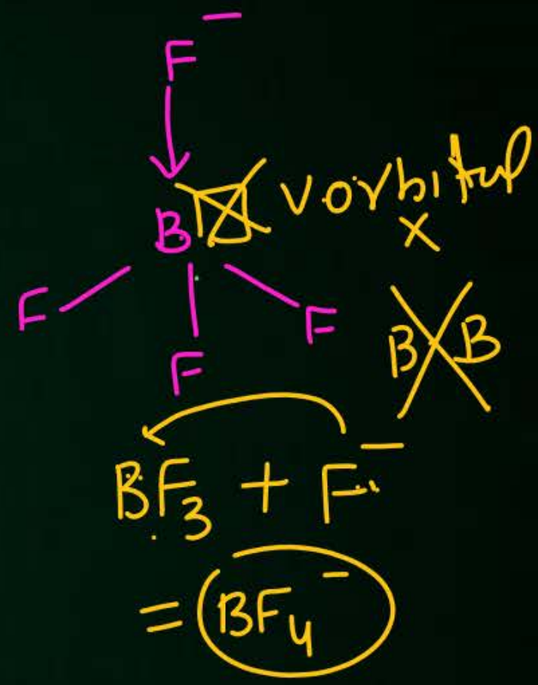
B·B

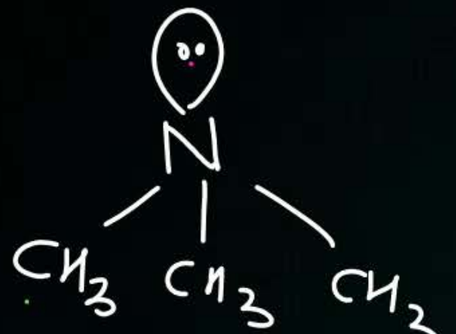


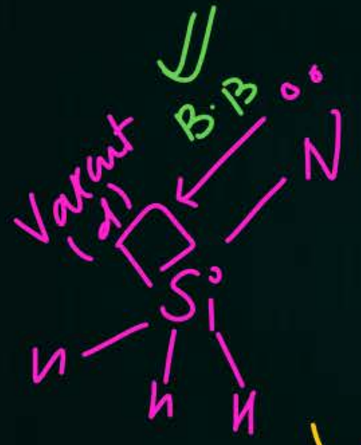
③ $BF_3 > BF_4^-$ (Bond Angle)

BF_3: 120°, sp^2, T. planar.

BF_4^-: 109.5°, sp^3, tetra







Si

3rd Period → 3s 3p 3d (Vacant)

l.p available at CA → NO

l.p Busy in B·B → yes

AB_3 — Pyramidal — $\theta < 109.5^\circ$

AB_3L_0 (T. planar)

$\theta = 120^\circ$

Changes which always occurs due to B·B

- → B·L ↓se
- → B·O ↑se
- → B·S ↑

If l·p of Central atom participate in B·B then

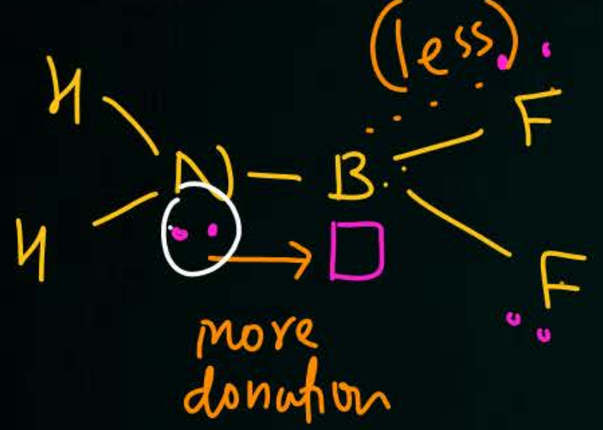
- geometry/shape
- Bond Angle (↑se)
- Hybrid state may also change
- Lewis Basic Nature ↓se
  (l·p of central atom busy in B·B
  thats why less available for other species)

NH_3 > NH_2-BF_2

B·B

(Lewis Basic Nature)

$NH_2 - BF_2$



C > N > O > F (donation strength)

$NH_3 > H_2\ddot{N}-BF_2$ (Lewis Basic Nature)

group 13th

Imp points :- ns^2np^1

Common O.S → +3 & +1

Inert Pair
- Stability of +1 ↑se down the group
- Stability of +3 ↓se down the group

($B^{+1} < Al^{+1} < Ga^{+1} < In^{+1} < Tl^{+}$)

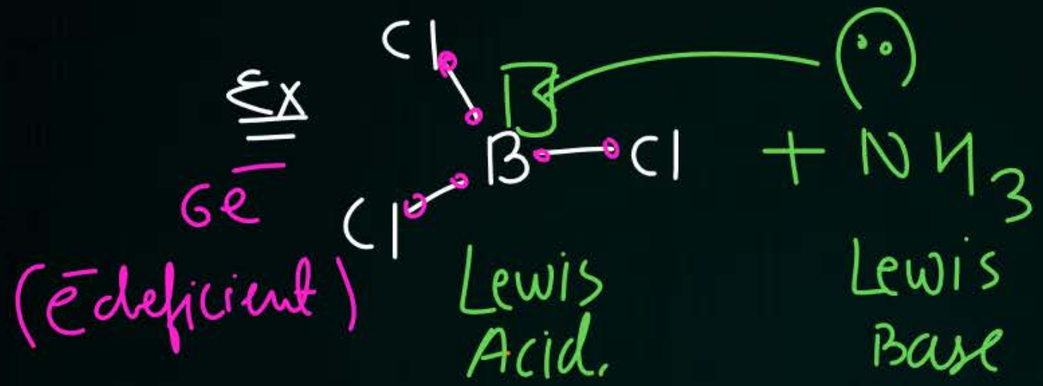
* +1 in Tl is predominant while +3 is oxidising in nature

$Tl^{3+} \longrightarrow Tl^{+1}$

* $E^{+1} > E^{3+}$ (Ionic character) O.A

Hint: Fajan's Rule

⇒ Boron trihalides are e^- deficient in Nature and can act as Lewis Acid.



$\longrightarrow NH_3 \cdot BCl_3$

⇒ $AlCl_3$.

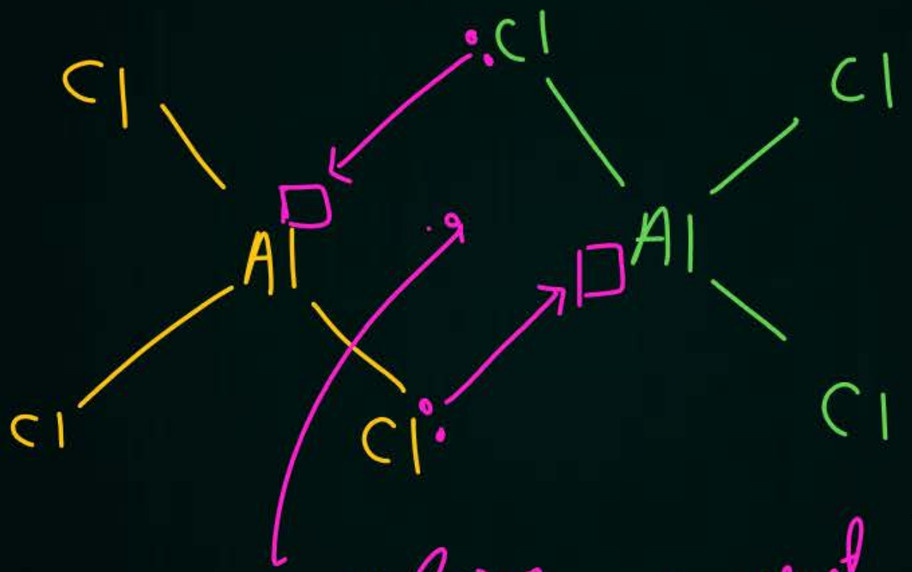
$AlCl_3$ remove its e^- deficiency by- (i) accepting l.p from e^- rich species like NH_3

$AlCl_3 + \ddot{N}H_3 \rightarrow NH_3 \cdot AlCl_3$

L.A L.B

(ii) By dimerisation. $AlCl_3 + AlCl_3$

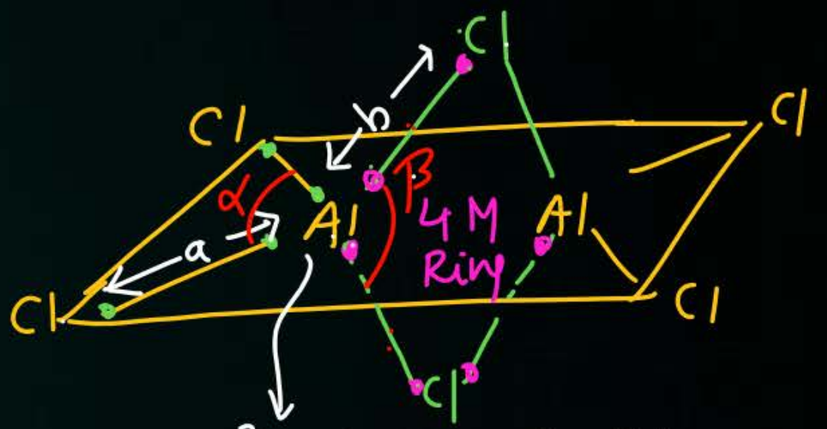
Al_2Cl_6 → Halogen Bridged dimer (Cl)



4 M Ring
Angle strain present
Repulsion

B.L ↑ → P ↑ S ↓

θ ↓



– sp^3 Hybridised Al

– $a < b$ (Bond lengths)

– $\alpha > \beta$ (Bond Angle)

α → Terminal Cl-Al-Cl B.A

β → Bridging Cl-Al-Cl B.A.

Chemical Reactivity :

(i) Reaction with Air $[O_2 + N_2]$

B & Al
Unreactive in Crystalline Form

But Can React in Amorphous Form

(A) $E + N_2 \longrightarrow \overset{+3\ 3-}{EN}$

Ex. BN, AlN ... etc.

(B) $E + O_2 \longrightarrow E_2O_3$

E^{3+} O^{2-} Ex B_2O_3

Al_2O_3 ... etc.

O^{2-} of B → Acidic (B_2O_3)

O^{2-} of Al & Ga → Amphoteric

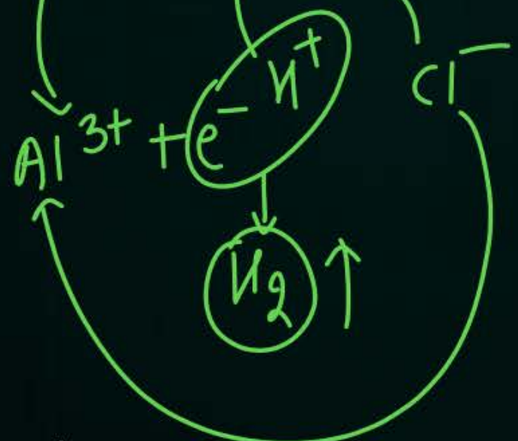
O^{2-} of In & Tl → Basic

(2) Reaction with Acid & Base :-

⇒ "B" donot react with Acid & Base.

Al → (Ampho) → Can React with Acid as well as Base

(i) $Al + HCl \longrightarrow \underbrace{Al^{3+}_{(aq)} \; Cl^{-}_{(aq)}}_{AlCl_3} + H_2\uparrow$



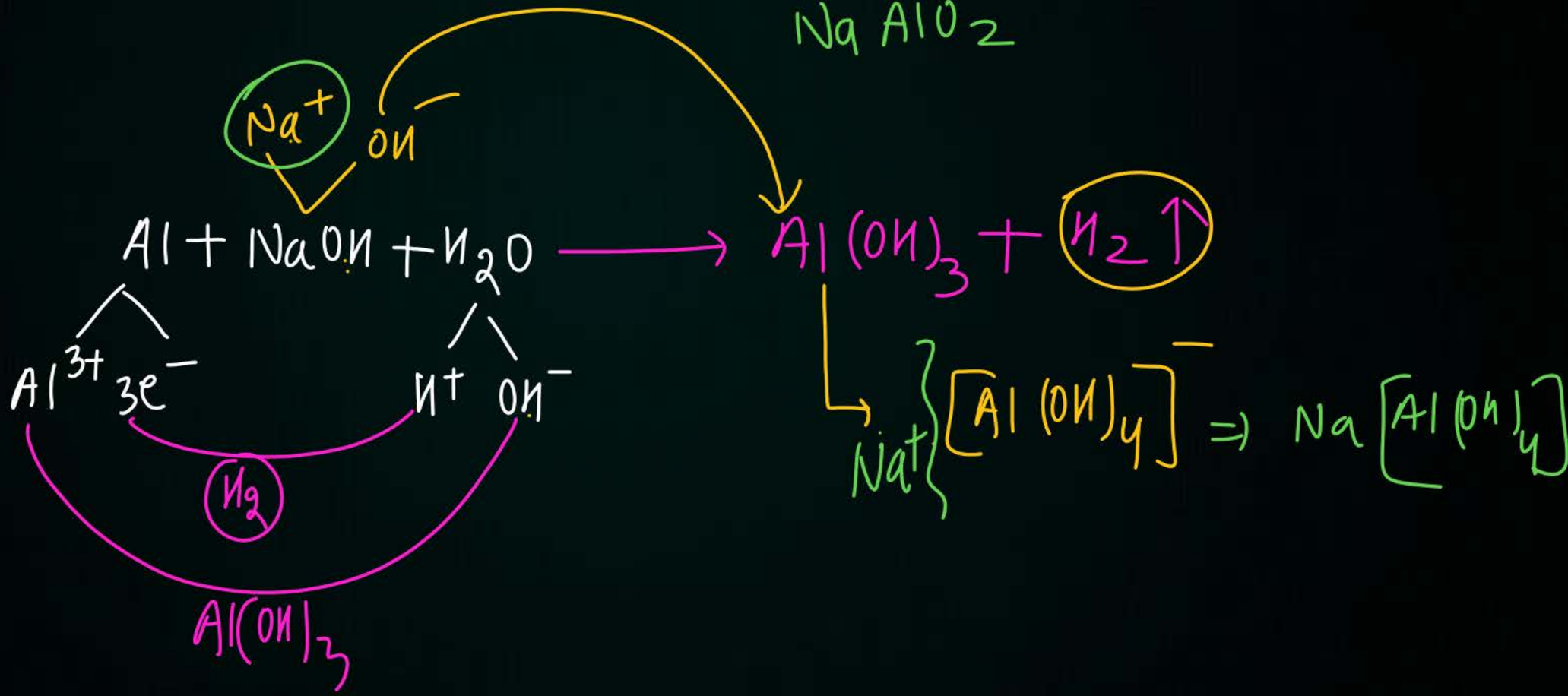
*. Al with $C.HNO_3$ ⟶ Passivation (Be, Al, Fe, Cr & Actinoids)

(ii) With Base

$$Al + NaOH_{(aq)} \longrightarrow Na[Al(OH)_4] + H_2\uparrow$$

or

$$NaAlO_2$$

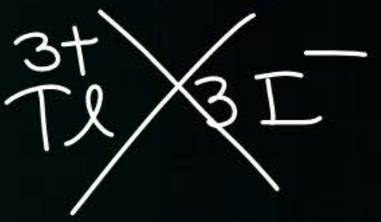


③ Reaction with Halogens

Trihalides

① $E + X_2 \longrightarrow \overset{+3}{E}X_3$

Except TlI_3



group - 14th

Imp. Points : ns^2np^2

* Common O.S → +2 & +4.

Stability +2 ↑se (T→B)

+4 ↓se (T→B)

* Pb^{+4} → Oxidising agent

* Sn^{+2} → Reducing Nature

Chemical Reactivity :-

C / Si / Ge / Sn / Pb

??

Reaction with Water - $H_2O_{(\ell)}$

* $E + H_2O_{(\ell)} \longrightarrow$ No Reaction

* But Can Reactwith Steam ($H_2O_{(g)}$)

For Ex $Sn + \text{steam} \longrightarrow SnO_2 + H_2 \uparrow$

Pb donot React with water due to Presence of protective oxide layer.

② Reaction with Halogens :-

$$E + X_2 \longrightarrow EX_2 \;/\; EX_4$$

dihalides / Tetrahalides.

NEET PYQ

All EX_4 are Covalent in Nature except PbF_4 & SnF_4

Reason → Cation Large ? – Fajan Kg Ult Ionic ↑

$GeX_4 > GeX_2$ ($+4$ vs $+2$)

$PbX_4 < PbX_2$ ($+4$ vs $+2$)

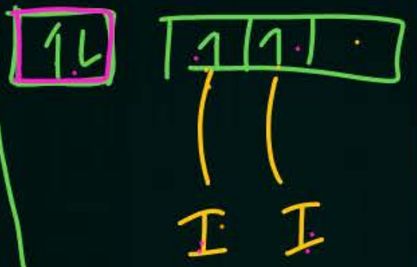
* PbI_4 does not Exist

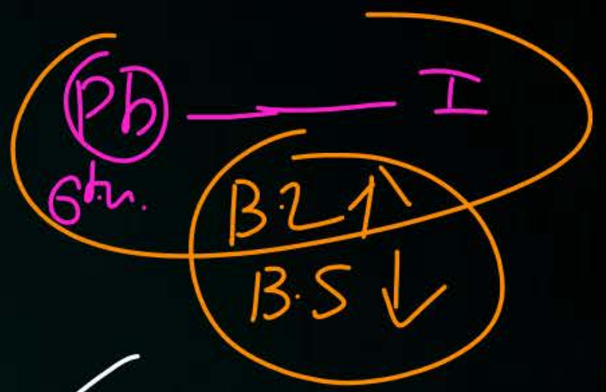
n=6

Pb [Xe] $4f^{14}\ 5d^{10}$ | $6s^2\ 6p^2$

$\sigma \downarrow$ $Z_{eff} \uparrow$ attraction on $6s^2 e^-$ $\uparrow$ se

Which Require More energy to unpair





PbI_4 ✗ PbI_2 ✓

Initially Formed two Pb-I Bonds are weak & do not release. Sufficient energy to Unpair $6s^2\ e^-$

THANK YOU

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FOR NEET 2025

Lecture - 03 | Inorganic Chemistry

The p-Block Elements

By - Mohit Dadheech (MD Sir)

Topics *to be covered*

1. group 15th, 16th, 17th.
2.
3.

NEET syllabus of p Block

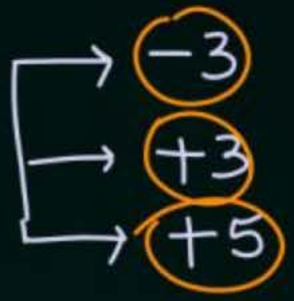
UNIT 10: P- BLOCK ELEMENTS

Group -13 to Group 18 Elements

General Introduction: Electronic configuration and general trends in physical and chemical properties of elements across the periods and down the groups; unique behaviour of the first element in each group.

group 15th

- Nitrogen Family. (Pnictogens)
- ns^2np^3 (5 valence e^-)
- Common O.S



* −3 O.S tendency ↓se down the group.
(∵ Top to bottom I.E ↓, Metallic ch 'ise)
* Bi Hardly form any Compound in −3

* +3 Stability ↑se & +5 Stability ↓se (Inert pair effe
* only well know Compound of Bi in
i/s ↓ O.S is → BiF_5

* N show all O.s (+1 to +5) in its oxides.

$\overset{+1}{N_2O}$ $\overset{+2}{NO}$ $\overset{+3}{N_2O_3}$ $\overset{+4}{N_2O_4}$ $\overset{+5}{N_2O_5}$

Neutral — Acidic.

* In case of N +1 to +4 all oxidation states have tendency to disproportionate

Ex $\underset{\text{Unstable}}{\overset{+3}{HNO_2}} \longrightarrow \overset{+2}{NO} + \overset{+5}{HNO_3}$

* P also disproportionates into -3 & $+5$.

$$\overset{+1}{H_3PO_2} \xrightarrow{\Delta} \overset{-3}{PH_3} + \overset{+5}{H_3PO_4}$$

$$\overset{+3}{H_3PO_3} \xrightarrow{\Delta} \overset{-3}{PH_3} + \overset{+5}{H_3PO_4}$$

Chemical Reactivity (Gp 15th)

N P As Sb Bi

With H_2

$E + H_2 \rightarrow EH_3$

NH_3

PH_3

AsH_3

SbH_3

BiH_3

With O_2

$E + O_2 \rightarrow \overset{+3}{E_2}O_3 / \overset{+5}{E_2}O_5$

$\overset{+5}{E_2}O_5 > \overset{+3}{E_2}O_3$ (acidic)

O^{2-} of N & P → Acidic

As, Sb → Ampho

Bi → Basic

With X_2

$E + X_2 \rightarrow \overset{+3}{E}X_3 / \overset{+5}{E}X_5$

$\overset{+5}{E}X_5 > \overset{+3}{E}X_3$ (covalent)

⇒ NX_5 do not exist (due to absence of vacant "d")

⇒ Amongst NX_3 only NF_3 is stable

NF_3 NCl_3 NBr_3 NI_3

↓

- Unstable
- Explosive

With Metals

Form N^{3-}, P^{3-}, As^{3-}, Sb^{3-},

Nitride

phosphide

Arsenide

Antimonide

Metal + E

group 16th :-

→ $ns^2 np^4$

→ Common O.S

↑se

Stability
↓se (T → B)

+4, +6

→ Oxygen (ENT) It shows mainly −2 O.S
(High EN)

But with F it can show +2

Ex $\overset{+2}{O}F_2$

Chemical Reactivity (Gp 16)

O S Se Te Po

With H_2

$E + H_2 \rightarrow H_2E$

- H_2O
- H_2S
- H_2Se
- H_2Te

With O_2

$E + O_2 \rightarrow \overset{+4}{EO_2} / \overset{+6}{EO_3}$

→ All are acidic ✓

→ SO_2 to TeO_2 (Reducing Nature ↓se)

→ In fact $TeO_2 \rightarrow$ O.A

$SO_2 \rightarrow$ R.A → $S^{+4} \rightarrow S^{+6}$ (R.A)

Te^{+4} (O.A) → Te^{2+}

With X_2

$E + X_2 \rightarrow \overset{+2}{EX_2} / \overset{+4}{EX_4} / \overset{+6}{EX_6}$

→ Amongst EX_6 only EF_6 are stable

$EX_4 \rightarrow AB_4L_1$

See-Saw

sp^3d

Ex SF_4 etc.

V. Imp group-17th

Halogen Family (ns^2np^5)

* Most Common O.S For all Halogens → (-1)

F always show -1 O.S

But Cl Br & I Can also show +ve O.S in their Oxides & InterHalogens.

Ex ClO_3, ClO_2

IF_3, ClF_3 ... etc.

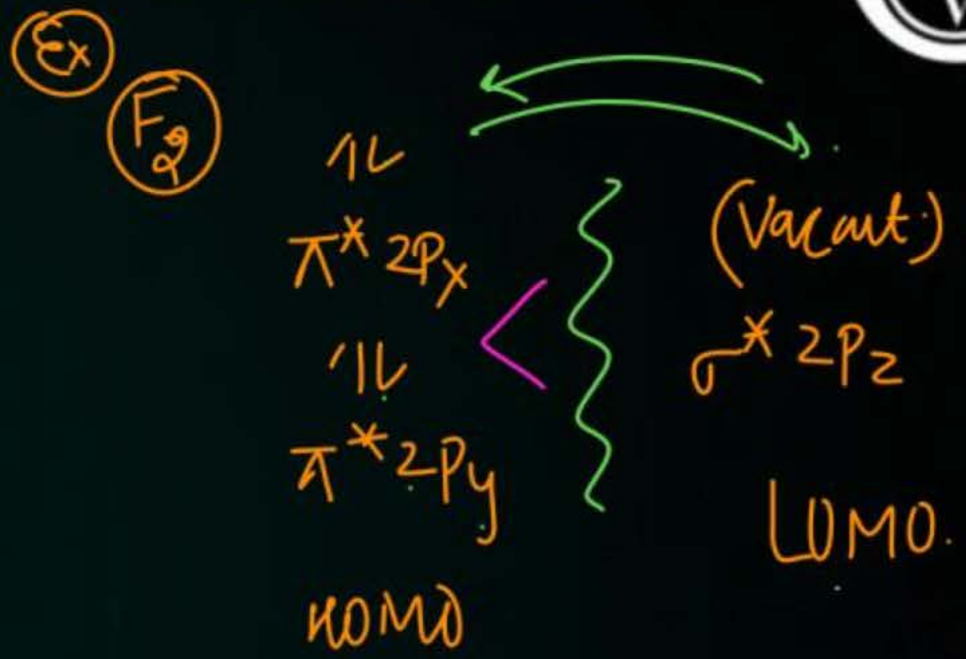
* Halogens are coloured due to HOMO – LUMO transition

F_2 → yellow

Cl_2 → greenish yellow

Br_2 → Brown.

I_2 → Violet



Bond dissociation Enthalpy (Halogens) (X_2)

$Cl_2 > Br_2 > F_2 > I_2$ (B.D.E or Bond energy)

Bond dissociation is lower than Expectations due to l.p – l.p repulsion

But B.L order is normal & Based on size

$F_2 < Cl_2 < Br_2 < I_2$ (B.L)

Halogens

X_2

$X-X$ → Non polar Molecules

$F_2 < Cl_2 < Br_2 < I_2$

M.W ↑ ; W.V.f ↑ T_{se} ; M.P ↑, B.P ↑

(L.D.F)

attraction b/w Molecules ↑ T_{se}

Physical state change gas → liquid → solid.

F_2, Cl_2 → gases.

Br_2 → liquid

I_2 → solid

at room temp

V.V.Imp

Oxidising Power of Halogens

Ready acceptance for an electron is main reason for strong oxidising Nature of Halogens.

Order

$$\underbrace{F_2 > Cl_2}_{\text{S.O.A.}} ? \underbrace{Br_2 > I_2}_{\text{W.O.A}} \quad (\text{oxidising Power})$$

NOTE F_2 is strongest oxidising agent due to :—

(i) Low dissociation Enthalpy (l.p-l.p repusion)

(ii) High Hydration Enthalpy. (Main)

$$\frac{1}{2}F_2 \xrightarrow[(Endo)]{\frac{1}{2}B.D.E} F_{(g)} \xrightarrow[(Exo)]{E.A} F^-_{(g)} \xrightarrow[\substack{Hydration\\ Energy\\ (Exo)}]{H_2O} F^-_{(aq)}$$

* Halogens are Strong O.A & Can Oxidise Halides (X^-) of Higher atomic number (even in Solid state)

Order $F_2 > Cl_2 > Br_2 > I_2$

✓ $F_2 + X^- \longrightarrow F^- + X_2$ ($X = Cl/Br/I$)

O.A

✓ $Cl_2 + X^- \longrightarrow Cl^- + X_2$ ($X = Br/I$)

~~$Cl_2 + F^- \longrightarrow Cl^- + F_2$~~

✓ $Br_2 + I^- \longrightarrow Br^- + I_2$

Oxidising Nature of Halogens can also observed by their Rxn with water :-

Fluorine oxidise water $F_2 + H_2O \longrightarrow HF + O_2 \uparrow$

Cl_2 & Br_2 disproportionate into water & give Hydrohalic & Hypohalous acids.

$Cl_2 + H_2O \longrightarrow \overset{-1}{H}\overset{}{Cl} + H\overset{+1}{O}Cl$ — HCl Hydrochloric & HOCl Hypochlorous

$Br_2 + H_2O \longrightarrow \overset{-1}{H}\overset{}{Br} + H\overset{+1}{O}Br$ — HBr Hydrobromic & HOBr Hypobromous

$I_2 + H_2O \longrightarrow$ No Reaction → Rxn of I_2 with water is non spont.

Reverse Reaction is spont.

$I^- + O_2 \longrightarrow O^{2-} + I_2$ ✓

Chemical Reactivity of group 17th Elements :-

(1) Reaction with Hydrogen :-

$$E + H_2 \longrightarrow HE$$

Ex HF, HCl, HBr, ... etc

(2) Reaction with O_2 :-

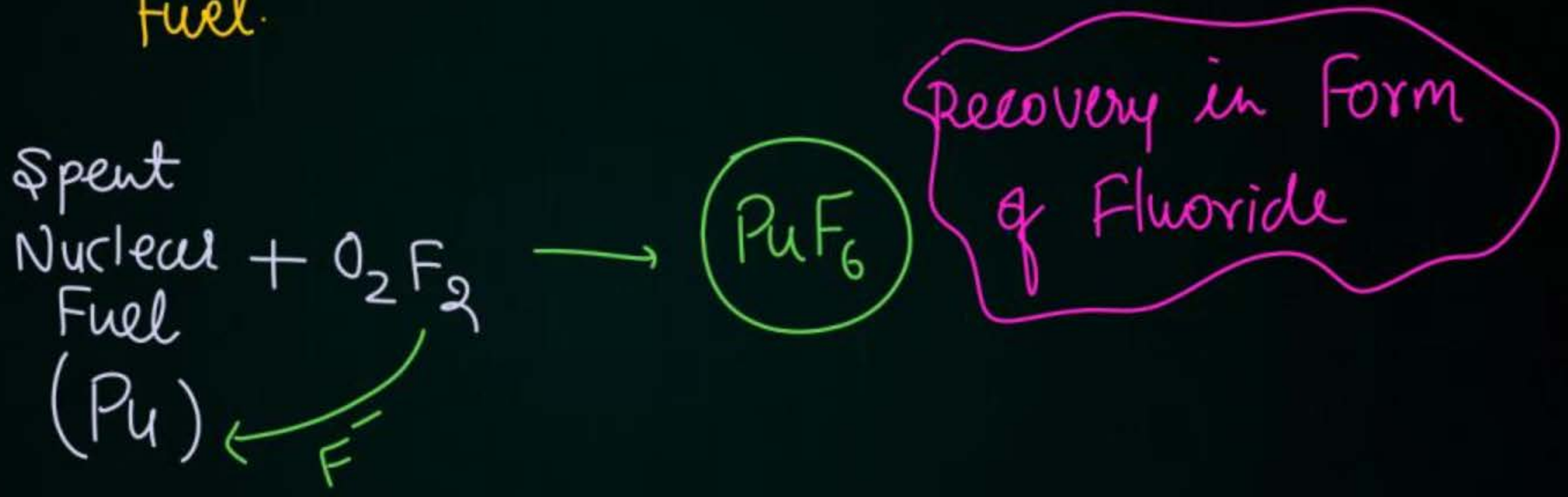
All Halogens Form oxides (most of them are Unstable)

(A) O^{2-} of Fluorine → These are essentially Fluorides of Oxygen ($\because F_{EN} > O_{EN}$)

Ex OF_2, O_2F_2 → Fluorinating agent.

Both are Fluorinating agent.

* O_2F_2 is used to recover Pu From Spent nuclear Fuel.



(B) O^{2-} of Cl

Ex Cl_2O, ClO_2, Cl_2O_6, Cl_2O_7

- All are oxidising agent.
- Reactive
- Explosive.

(C) O^{2-} of Br

Ex Br_2O, BrO_2, BrO_3] Powerful O.A.

Very less stable.

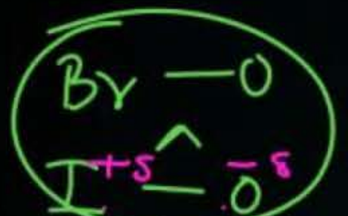
(D) O^{2-} of I

I_2O_4 I_2O_5 I_2O_7 → Solid at room temp (Ionic)
Insoluble
(∵ large ΔE blw O & I)

O.A ↓
Used in estimation of CO

Imp NOTE

Stability order of O^{2-} of Cl, Br, I



(Polarity)

O^{2-} of I > O^{2-} of Cl > O^{2-} of Br

$+\delta \quad -\delta$

$I - O$

More polar Bond due to less EN of I

Ionic ch ↑se

Extra attraction.

stability ↑se

Cl < Br (size)

∴ Cl is capable to Form multiple Bonds (π) with oxygen

Br lacks in Both. thats why least stable.

(3) Reaction with Metals

X_2 + Metal ⟶ Metal Halides
(MX)

$MF < MCl < MBr < MI$ (covalent ch)

(Fajan's Rule)

$F^- < Cl^- < Br^- < I^-$ (Polarisability)

$SnCl_2 < SnCl_4$

$SbCl_3 < SbCl_5$

(4) Reaction with Halogens :–

diff
Halogen + Halogen → Inter Halogen.

$X + X^1 \longrightarrow XX^1 / XX^1_3 / XX^1_5 / XX^1_7$

Ex

BrF, ICl, ClF $XX^1 \rightarrow$ linear

BrF_3, ClF_3 $XX^1_3 \rightarrow$ Bent T sp^3d (AB_3L_2)

ClF_5, IF_5, BrF_5 $XX^1_5 \rightarrow$ Sq. Pyramidal. sp^3d^2 (AB_5L_1)

IF_7 $XX^1_7 \rightarrow$ Pentagonal Bipyramidal (AB_7L_0) sp^3d^3

Inter Halogens

Polar Bonds

Polar } Polar

dipole-dipole

More attraction b/w Molecules

More M.P & B.P

Halogens

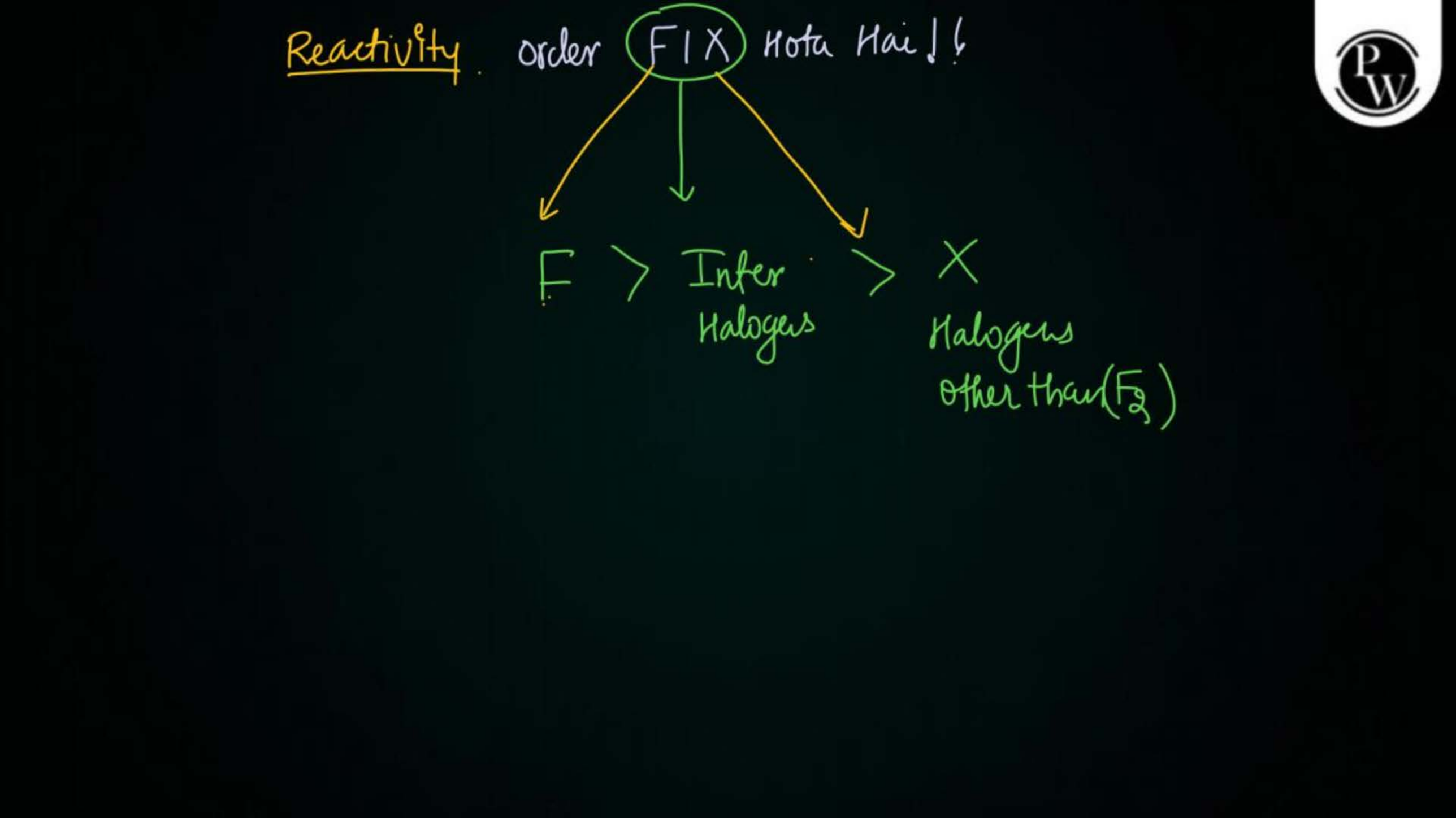
Non polar Bonds.

N.P } N.P

LDF

Comparitively less attraction.

Low M.P & B.P


Reactivity order F I X Hota Hai !!
F > Inter Halogens > X Halogens other than (F_2)

V.V. Imp **Imp Properties of gp 15th 16th & 17th Hydrides :–**

NH_3	H_2O	HF
PH_3	H_2S	HCl
AsH_3	H_2Se	HBr
SbH_3	H_2Te	HI

- E–H Bond length ↑se
- E–H Bond dissociation energy ↓se
- Thermal stability ↓
- Reducing Nature ↑se

[∵ B.L.↑ H removal easy (Oxidation)]

→ H^+ donation tendency in aq. Medium ↑se

→ Acidic Nature ↑

→ pKa value ↓se

l.p donation tendency ↓se
Lewis Basic Natur ↓se

$NH_3 > PH_3 > AsH_3 > SbH_3$
(Lewis Basic order)

M.P → 1, 1, 2
(Trick)
B.P → 2, 1, 1

Bond Angle (15th, 16th) ↓se
(∵ Size C.A ↑ θ ↓)

↘ Revise from chemical Bonding Chapter

group-18th.

Inert gases / Noble gases

Except Rn & Og all are Found in atmosphere
(86) (118)

(Max Ar ~0.9% in dry air)

Noble gases

↳ Reason due to their Full Filled configuration

ns^2np^6

Except He
$1s^2$

Chemical properties :-

* Very less reaction (Almost Unreactive)
  - (i) due $ns^2 np^6$ configuration
  - (ii) due to Very High I.E (Na to lenge)
    &
    +ve electron gain enthalpy (Na hi lenge)

* In 1962 first Compound of Inertgas Was prepared.

$Xe[PtF_6]$ Bartlett Compound.

Red colour Complex.

Reason of Formation :-

$Xe \approx O_2$ (I.E)

$O_2^+\{[PtF_6]^-$	$Xe^+\{[PtF_6]^-$
Red. Comp.	Red

After this Some more Compounds of Xe & Kr have been synthesised.

(only with High E.N., O & F)

Ex. XeF_6, XeF_4, XeO_2F_2, $XeOF_4$

KrF_2 etc.

"Their is no true compounds of He, Ne, Ar Present"

* Og is Radioactive (Half life 0.7 milliseconds)

Some imp. properties :-

* All are monoatomic ✓
  Colourless, odourless
  tasteless
* Sparingly soluble in water
* Low M.P & B.P (Lowest → He)

He
Ne
Ar
Kr
Xe
Rn

Atomic Size ↑se
Surface area ↑se → adsorption on charcoal ↑se
I.E ↓
Atomic mass ↑
Density ↑
M.P & B.P ↑ (∵ LDF ↑)
Solubility in water ↑se (DID ↑se)
Ideal character ↓
Real gas character ↑

Xenon Fluorides Compounds :-

Preparation

$$Xe + F_2 \longrightarrow XeF_2$$
(Excess)

$$Xe + F_2 \longrightarrow XeF_4$$
(1 : 5)

$$Xe + F_2 \longrightarrow XeF_6$$
(1 : 20)

all are crystalline solids & fluorinating agent

XeF_6 can also prepared by Rxn of O_2F_2 with XeF_4

$$XeF_4 + O_2F_2 \rightarrow XeF_6$$

Hydrolysis of XeFluorides

$$\overset{+2}{XeF_2} + H_2O \longrightarrow Xe + HF + O_2$$

$$\overset{+4}{XeF_4} + H_2O \longrightarrow \overset{+6}{XeO_3} + \overset{0}{Xe} + HF + O_2$$

$$\overset{+6}{XeF_6} \xrightarrow{\text{Partial}\,(1.H_2O)} XeOF_4 + HF$$

$$\overset{+6}{XeF_6} \xrightarrow{\text{Partial}\,(2\,H_2O)} XeO_2F_2 + HF$$

$$\overset{+6}{XeF_6} \xrightarrow{\text{Complete}\,(3H_2O)} XeO_3 + HF$$

(MDJ)

* Xe +6 Mai Rahega.
* HF Common.
* X Product Mai Xe Ke Sath Utna Oxygen Jitna Water liya.

F^- Exchange Reactions

$XeF_2 + PF_5 \rightarrow [XeF]^+ [PF_6]^-$

$XeF_4 + SbF_5 \rightarrow [XeF_3]^+ [SbF_6]^-$

$XeF_6 + CsF \rightarrow Cs^+ [XeF_7]^-$

$XeF_4 + RbF \rightarrow Rb^+ [XeF_5]^-$

$XeF_2 + BiF_5 \rightarrow [XeF]^+ [BiF_6]^-$

#MDJ

Xe Fulorides with p-Block → F^- donor

Xe Fulorides with s-Block / Comp → F^- acceptor

Group 18

Uses

- All these gases except radon and oganesson occur in the atmosphere.
- Their atmospheric abundance in dry air is ~ 1% by volume of which argon is the major constituent.
- All the noble gases are monoatomic. They are colourless, odourless and tasteless. They are sparingly soluble in water.
- They have very low melting and boiling points because the only type of interatomic interaction in these elements is weak dispersion forces. (L·D·F)
- Helium has an unusual property of diffusing through most commonly used laboratory materials such as rubber, glass or plastics.

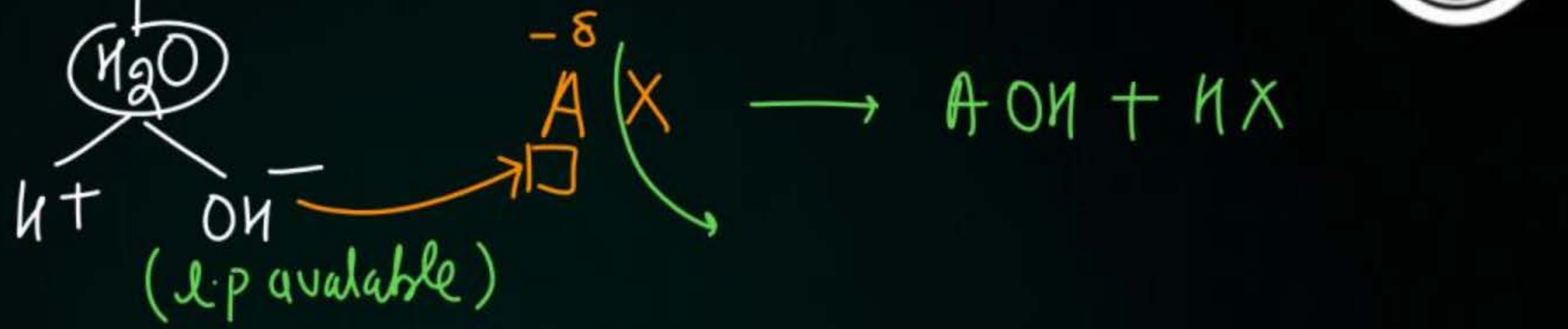
- Helium is a non-inflammable and light gas. Hence, it is used in filling balloons for meteorological observations. It is also used in gas-cooled nuclear reactors. Liquid helium (b.p. 4.2 K) finds use as cryogenic agent for carrying out various experiments at low temperatures. It is used to produce and sustain powerful superconducting magnets which form an essential part of modern NMR spectrometers and Magnetic Resonance Imaging (MRI) systems for clinical diagnosis. It is used as a diluent for oxygen in modern diving apparatus because of its very low solubility in blood.

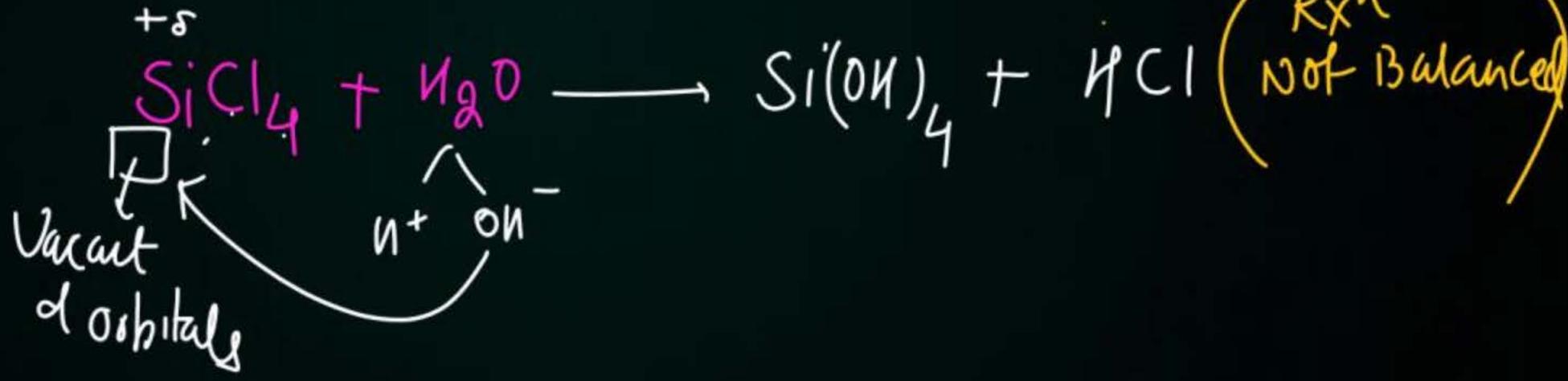
V. Imp

- Neon is used in discharge tubes and fluorescent bulbs for advertisement display purposes. Neon bulbs are used in botanical gardens and in green houses.

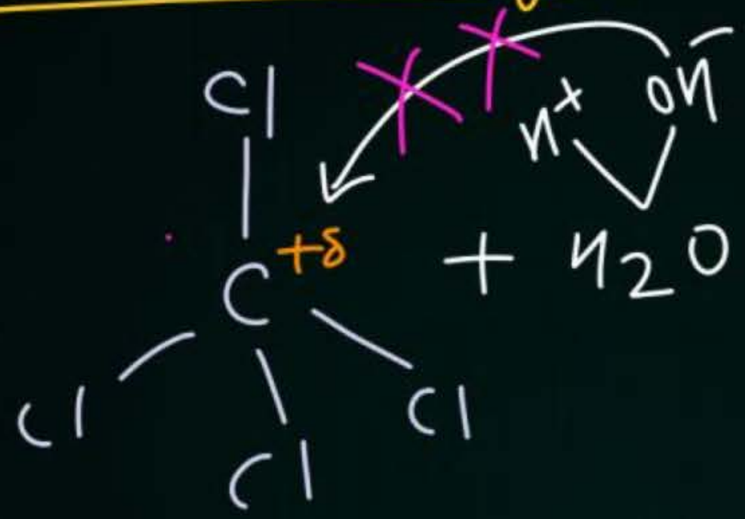
- Argon is used mainly to provide an inert atmosphere in high temperature metallurgical processes (arc welding of metals or alloys) and for filling electric bulbs. It is also used in the laboratory for handling substances that are air-sensitive. There are no significant uses of Xenon and Krypton. They are used in light bulbs designed for special purposes.

Hydrolysis Pani ka Break Hokar Rxn Karna.





CCl_4 do not Hydrolyze. Why ??



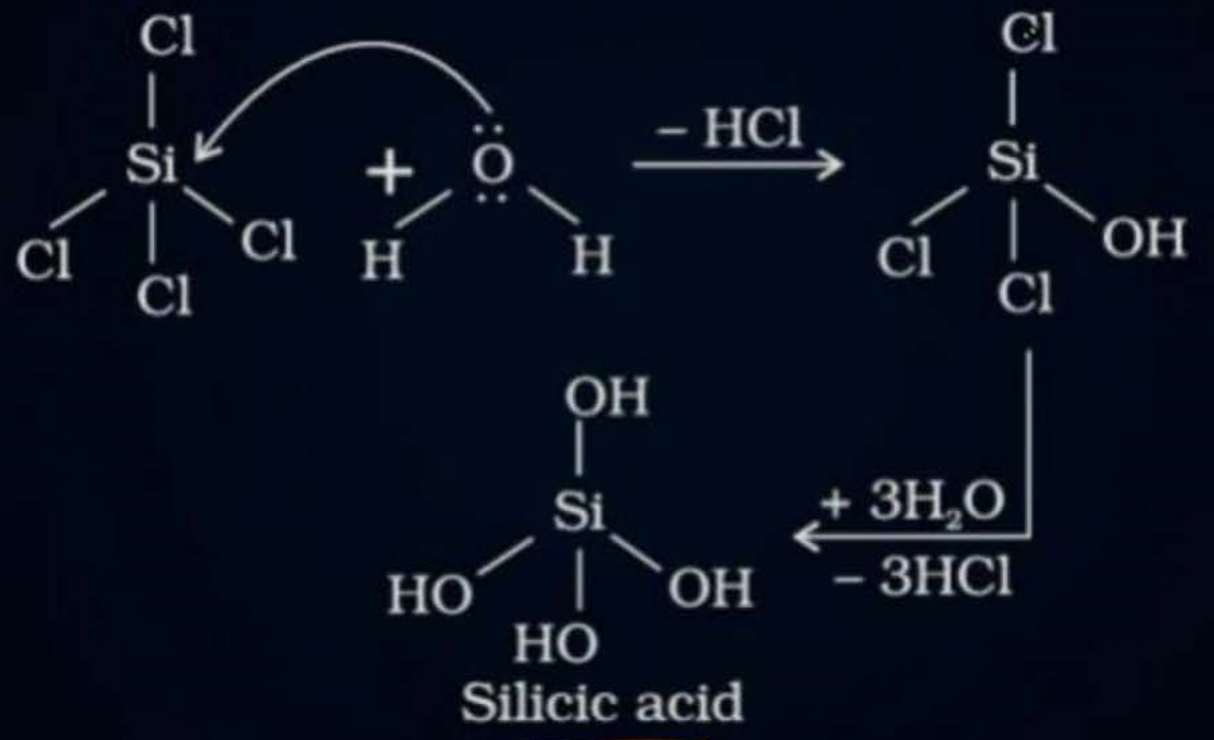
+s charge at C.A ✓✓

Vacant orbital at C.A · XX

} – Hydrolysis

NCERT group 14th

Hydrolysis can be understood by taking the example of $SiCl_4$. It undergoes hydrolysis by initially accepting lone pair of electrons from water molecule in d orbitals of Si, finally leading to the formation of $Si(OH)_4$ as shown below :



Silicic acid

Anomalous nature of 2nd period elements

B, C, N, O, F

Reasons:- (1) Absence of Vacant "d" orbitals.

(2) Small size.

(A) High I.E ✓

(B) High EN ✓

Imp. Points :-

1. due to Small size 2nd period elements are able to form $p\pi - p\pi$ type multiple Bonds with itself & other Second row elements having Small size & High EN.

For Ex:- $C=C$, $C\equiv C$

$C=O$, $C\equiv N$

$N\equiv N$, $N=O$, $O=O$

(2.) Heavier Members (3d periods & onwards)

Can also form π Bonds.

But they involves "d" orbitals in π Bonding

$d\pi - p\pi$, $d\pi - d\pi$.

NOTE :- $p\pi - p\pi$ Type of Bonding is not stable in heavier Members

$3p\pi - 3p\pi < 3d\pi - 3p\pi < 3d\pi - 3d\pi$

Weakest not exist

But $2p\pi - 2p\pi > 3d\pi - 3d\pi > 3d\pi - 3p\pi > 3p\pi - 3p\pi$

(3.) due to Strong C–C Bond it show Catenation properties.

Top to bottom Catenation ↓se ⇒ $C >> Si > Ge \approx Sn$ (Imp)

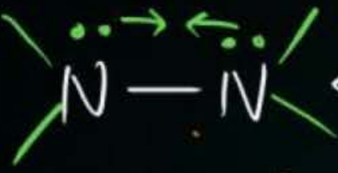
Pb do not show Catenation ✓

(4). N_2 is very less Reactive due to very High Bond dissociation Energy $(N \equiv N)$

NOTE

$N \equiv N$ ($2P_\pi$–$2P_\pi$) ✓ ; $P \equiv P$ ($3P_\pi$–$3P_\pi$) ✗ ; $As \equiv As$ ($4P_\pi$–$4P_\pi$) ✗ ; $Sb \equiv Sb$ ✗

N – N ✓ ; P – P ✓ ; As – As ✓ ; Sb – Sb ✓

$\Rightarrow$  $< P-P$

due to l.p - l.p Repulsion ✓ Chemical Bonding Chapter.

(5.) due to Small size & High EN of "O"

H-Bonding is present in H_2O & it is liquid.

But H_2S is gas (H-Bondig absent)

(6) HF is liquid at room temp while other Hydrogen Halides are gases -

∵ Small size & High EN of F] HF /// HF /// HF

H-Bonding ✓

Anomalous behaviour of 2nd period elements

"Homeworks"

Boron Family

- The first member of p-block differs from the remaining members of their corresponding group in two major respects. First is the size and all other properties which depend on size. Thus, the lightest p-block elements show the same kind of differences as the lightest s-block elements, lithium and beryllium. The second important difference, which applies only to the p-block elements, arises from the effect of d-orbitals in the valence shell of heavier elements (starting from the third period onwards) and their lack in second period elements. The second period elements of p-groups starting from boron are restricted to a maximum covalence of four (using 2s and three 2p orbitals). In contrast, the third period elements of p-groups with the electronic configuration $3s^2 3p^n$ have the vacant 3d orbitals lying between the 3p and the 4s levels of energy. Using these d-orbitals the third period elements can expand their covalence above four. For example, while boron forms only $[BF_4]^-$, aluminium gives $[AlF_6]^{3-}$ ion.

Carbon Family

- Carbon cannot exceed its covalence more than 4, other elements of the group can do so. It is because of the presence of d orbital in them. Due to this, their halides undergo hydrolysis and have tendency to form complexes by accepting electron pairs from donor species. For example, the species like, SiF_6^{2-}, $[GeCl_6]^{2-}$, $[Sn(OH)_6]^{2-}$ exist where the hybridisation of the central atom is sp^3d^2.

- Carbon also has unique ability to form pπ– pπ multiple bonds with itself and with other atoms of small size and high electronegativity. Few examples of multiple bonding are: C=C, C ≡ C, C = O, C = S, and C ≡ N.

- Heavier elements do not form pπ– pπ bonds because their atomic orbitals are too large and diffuse to have effective overlapping.

- Carbon atoms have the tendency to link with one another through covalent bonds to form chains and rings. This property is called catenation. This is because C—C bonds are very strong. Down the group the size increases and electronegativity decreases, and, thereby, tendency to show catenation decreases. The order of catenation is **C > > Si > Ge ≈ Sn.**

- Lead does not show catenation.

Nitrogen Family

- Except nitrogen, all the elements show allotropy.

- The only well characterized Bi (V) compound is BiF_5.
- In the case of nitrogen, all oxidation states from +1 to +4 tend to disproportionate in acid solution.
- Similarly, in case of phosphorus nearly all intermediate oxidation states disproportionate into +5 and –3 both in alkali and acid. However +3 oxidation state in case of arsenic, antimony and bismuth becomes increasingly stable with respect to disproportionation.

- Nitrogen has unique ability to form pπ-pπ multiple bonds with itself and with other elements having small size and high electronegativity (e.g., C, O).

- Nitrogen exists as a diatomic molecule with a triple bond (ones and two p) between the two atoms. Consequently, its bond enthalpy (941.4 kJ mol^{-1}) is very high. On the contrary, phosphorus, arsenic and antimony form single bonds as P–P, As–As and Sb–Sb while bismuth forms metallic bonds in elemental state. However, the single N–N bond is weaker than the single P–P bond because of high interelectronic repulsion of the non-bonding electrons, owing to the small bond length.

- Nitrogen cannot form dπ–pπ bond as the heavier elements can e.g., $R_3P = O$ or $R_3P = CH_2$ (R = alkyl group). Phosphorus and arsenic can form dπ –dπ bond also with transition metals when their compounds like $P(C_2H_5)_3$ and $As(C_6H_5)_3$ act as ligands.

Synergic Bonding

$\ddot{P}R_3$ Acid ligand

Anomalous behaviour of oxygen

- The anomalous behaviour of oxygen, like other members of p-block present in second period is due to its small size and high electronegativity. One typical example of effects of small size and high electronegativity is the presence of strong hydrogen bonding in H_2O which is not found in H_2S.

- The absence of d orbitals in oxygen limits its covalency to four and in practice, rarely exceeds two. On the other hand, in case of other elements of the group, the valence shells can be expanded and covalence exceeds four.

- Reducing property of dioxide decreases from SO_2 to TeO_2; SO_2 is reducing while TeO_2 is an oxidising agent.

Anomalous behaviour of F

- Most of the reactions of fluorine are exothermic (due to the small and strong bond formed by it with other elements). It forms only one oxoacid while other halogens form a number of oxoacids. Hydrogen fluoride is a liquid (b.p. 293 K) due to strong hydrogen bonding.

QUESTION

Elements of group-15 form compounds in +5 oxidation state. However, bismuth forms only one well characterized compound in +5 oxidation state. The compound is.....

1. Bi_2O_5
2. BiF_5
3. $BiCl_5$
4. Bi_2S_5

QUESTION

In the preparation of compounds of Xe, Bartlett had taken $O_2^+PtF_6^-$ as a base compound. This is because .....

1. Both O_2 and Xe have same size.
2. Both O_2 and Xe have same electron gain enthalpy
3. Both O_2 and Xe have almost same ionization enthalpy.
4. Both Xe and O_2 are gases.

QUESTION

Which of the following orders are correct as per the properties mentioned against each ?

1. $SiO_2 < As_2O_3 < P_2O_3 < SO_2$ Acid strength

2. $AsH_3 < PH_3 < NH_3$ Enthalpy of vaporization (B.P order)

3. $S < O < Cl < F$ More negative electron gain enthalpy

4. $H_2O > H_2S > H_2Se > H_2Te$ Thermal stability

QUESTION

Which of th following options are not in accordance with the property mentioned against them ?

1. $F_2 < Cl_2 > Br_2 > I_2$ (oxidizing power) ✗
2. MI > MBr > MCl > MF (Ionic character of metal halide) ✗
3. $F_2 > Cl_2 > Br_2 > I_2$ Bond dissociation enthalpy ✗
4. HI < HBr < HCl < HF (Hydrogen-halogen bond strength) ✓

Ans

1, 2, 3

QUESTION

Which of the following statements are true ?

1. Only type of interactions between particles of noble gaes are due to weak dispersion forces . ✓

2. Ionization enthalpy of molecular oxygen is very close to that of xenon. ✓

3. Hydrolysis of XeF_6 is a redox reaction. ✗

4. Xenon fluorides are not reactive. ✗

1, 2

QUESTION

Which of the following order regarding thermal stability of hydrides MH_3 of group 15 is correct ?

1. $NH_3 > PH_3 > AsH_3$
2. $NH_3 < PH_3 < AsH_3$
3. $NH_3 > PH_3 < AsH_3$
4. $NH_3 < PH_3 > AsH_3$

QUESTION

Which of the following statements is not correct about oxides of group-16 ?

1. Reducing property of dioxide decreases from SO_2 to TeO_2.
2. Acidic nature decreases from SO_3 to TeO_3.
3. S, Se and Te form both EO_2 and EO_3 types oxides.
4. None of the above

QUESTION

Select interhalogen compound which is/are not exist ?

(i) IF_3 (ii) ClF_7 (iii) ClF_3 (iv) BrF_4

1. (i) and (iv)
2. (ii) and (iv)
3. (ii) Only
4. (ii) and (iii)

QUESTION

Molecular size of I–Cl and Br_2 is nearly same but boiling point of I–Cl is about 40°C higher than Br_2. This might be due to :

1. I–Cl bond is stronger than Br–Br–bond
2. Ionisation energy of I < I.E. of Br
3. I–Cl is polar whereas Br_2 is non-polar
4. Size of I > size of Br

QUESTION

$Br_2 + 2X^- \longrightarrow 2Br^- + X_2$

$Cl_2 + 2Y^- \longrightarrow 2Cl^- + Y_2$

The incorrect match regarding above reaction is :

1. $X_2 = I_2$
2. $Y_2 = I_2$
3. $X_2 = Cl_2$
4. $Y_2 = Br_2$

QUESTION

Correct reaction for layer test of I^- ion is :

1. $NaF + I_2 \xrightarrow{CCl_4} NaI + F_2$

2. $NaBr + I_2 \xrightarrow{CCl_4} NaI + Br_2$

3. $NaI + Cl_2 \xrightarrow{CCl_4} NaCl + I_2$

4. $NaI + H_2O \xrightarrow{CCl_4} I_2 + NaOH$

QUESTION

Which of the following halogen disproportionate in water ?

1. F_2
2. Cl_2
3. I_2
4. All of these

QUESTION

Which of the following is correct statement ?

1. F_2 has higher dissociation energy than Cl_2
2. F has higher electron affinity than Cl
3. HF is stronger acid than HCl.
4. Boiling point increases down the group in halogens

QUESTION

The compound that cannot be formed by xenon is :

1. XeO_3
2. XeF_4
3. $XeCl_4$
4. XeO_2F_2

QUESTION

AB_4L_2 Sq. Planar

Xenon tetrafluoride, XeF_4 is :

1. Tetrahedral and acts as a fluoride donor with SbF_5
2. Square planar and acts as a fluoride donor with PF_5
3. Square planar and acts as fluoride donor with NaF
4. See-saw shape and acts as a fluoride donot with AsF_5

QUESTION

(A) I^- (B) ClO_4^-

(C) NO_2 (D) HNO_2

(E) Cu^{2+} (F) Cu^+

The following ion can disproportionate :

1. C, D, F
2. B, C, D, E
3. C, D, E
4. A, C, D, F

QUESTION

$PbO_2 \longrightarrow PbO$; $\Delta G < 0$

$SnO_2 \longrightarrow SnO$; $\Delta G > 0$

Most probable oxidation state of Pb and Sn will be :

1. Pb^{4+}, Sn^{4+}
2. Pb^{4+}, Sn^{2+}
3. Pb^{2+}, Sn^{2+}
4. Pb^{2+}, Sn^{4+}

QUESTION

Which reaction is not feasible ?

1. $2KI + Br_2 \rightarrow 2KBr + I_2$

2. $2KBr + I_2 \rightarrow 2KI + Br_2$

3. $2KBr + Cl_2 \rightarrow 2KCl + Br_2$

4. $2H_2O + 2F_2 \rightarrow 4HF + O_2$

QUESTION

In the ground state of phosphorus, total number of unpaired electrons are :

H.W

1. 3
2. 5
3. 8
4. 9

QUESTION

Which of the following sulphur containing species cannot act as oxidizing agent ?

1. H_2S^{2-}

S^{2-} O A

2. H_2SO_4
3. SO_2
4. H_2SO_3

QUESTION

The correct order of relative acidity is :

1. $HClO > HClO_2 > HClO_3 > HClO_4$
2. $HClO_4 > HClO_3 > HClO_2 > HClO$
3. $HClO > HClO_2 > HClO_4 > HClO_3$
4. $HClO_3 > HClO_2 > HClO_4 > HClO$

O.S ↑ EN ↑ Acidic Nature ↑

H.W

QUESTION

The element which forms oxides in all oxidation states

1. P
2. Sb
3. N
4. As

QUESTION

Inert gases do not react with other elements because :

1. They are monoatomic
2. They have small size
3. They have completely paired up and stable electron shells
4. The yare found in abundance

QUESTION

Halogens are coloured because :

1. Their atoms have high electronegativity

2. Their molecules are hold together by weak van der waal's forces

3. Their molecules absorb visible light causing excitation of outer electrons to higher energy levels

4. Their atoms absorb energy causing the excitation of outer electrons to higher energy levels

QUESTION

Which of the following gas mixture is used by divers inside the sea ?

1. $O_2 + He$
2. $O_2 + N_2$
3. $O_2 + Xe$
4. $O_2 + Ar$

H.W

QUESTION

In which of the following arrangements the given sequence is not strictly according to the property indicated against it ?

1. HF < HCL < HBr < Hi increasing acidic strength

2. $H_2O < H_2S < H_2Se < H_2Te$ increasing pK_a values

H·W

3. $NH_3 < PH_3 < AsH_3 < SbH_3$ increasing acidic strength

4. $CO_2 < SiO_2 < SnO_2 < PbO_2$ increasing oxidising power

QUESTION

The property which is not true about fluorine is :

1. Most of the reactions are exothermic

H.W

2. It forms only one oxoacid

3. Highest electronegativity

4. High F–F bond dissociation energy

QUESTION

Which of the following elements forms $p\pi$-$p\pi$ bond with itself ?

1. N
2. Te
3. P
4. Se

H.W

QUESTION

In the structure of ClF_2, the number of lone pair of electrons on central atom Cl is :

1. Four
2. Two
3. One
4. Three

QUESTION

Which of the following is incorrect statement ?

n.w

1. $SiCl_4$ is easily hydrolysed.
2. GeX_4 (X = F, Cl, Br, I) is more stable that GeX_2.
3. SnF_4 is ionic in nature.
4. PbF_4 is covalent in nature.

QUESTION

Which of the following is not tetrahedral in shape?

1. NH_4^+
2. $SiCl_4$
3. SF_4
4. SO_4^{2-}

QUESTION

PCl_5 is possible but NCl_5 does not exist because :

1. ionization energy of N is high
2. in N, d-subshell is absent
3. it does not like Cl
4. none of the above

QUESTION

The following are some statements related to VA group hydrides :

(i) Reducing property increases from NH3 to BiH_3.

(ii) Tendency to donate lone pair decreases from NH_3 to BiH_3.

(iii) Thermal stability of hydrides decreases from NH_3 to BiH_3.

(iv) Bond angle of hydrides decreases from NH3 to BiH_3.

The correct statements are

H.W

1. (i), (ii), (iii) and (iv)
2. (i), (iii) and (iv)
3. (i), (ii) and (iv)
4. (i) and (iv)

QUESTION

The p-Block element that forms predominantly basic oxide is :

1. N
2. P
3. As
4. Bi

N.W

QUESTION

It is because of inability of ns^2 electrons of the valence shell to participate in bonding that :

1. Sn^{2+} is oxidizing while Pb^{4+} is reducing

H.W

2. Sn^{2+} and Pb^{2+} are both oxidizing and reducing

3. Sn^{4+} is reducing while Pb^{4+} is oxidizing

4. Sn^{2+} is reducing while Pb^{4+} is oxidizing

QUESTION

Which of the following species is not stable?

1. $[GeCl_6]^{2-}$
2. $[Sn(OH)_6]^{2-}$
3. $[SiCl_6]^{2-}$
4. $[SiF_6]^{2-}$

QUESTION

Which of the following species cannot exists?

1. $[BF_6]^{3-}$
2. $[AlF_6]^{3-}$
3. $[GaF_6]^{3-}$
4. $[InF_6]^{3-}$

H.W

Hint 2nd period
Max covalency = 4

QUESTION

Melting point is highest for:

1. B
2. Al
3. Ga
4. In

QUESTION

The increasing order of atomic radii of the following group 13 elements is

1. Al > Ga < In < Tl
2. Ga < Al < In < Tl
3. Al < In < Ga < Tl
4. Al < Ga < Tl < In

QUESTION

Stability of +1 oxidation state increases

N·W

1. Al < Ga < In < Tl
2. Tl < In < Ga < Al
3. In < Tl < Ga < Al
4. Ga < In < Al < Tl

QUESTION

The stability of dihalides of Si, Ge, Sn and Pb increases steadily in the sequence

1. $PbX_2 < SnX_2 < GeX_2 < SiX_2$

H.W

2. $GeX_2 < SiX_2 < SnX_2 < PbX_2$

3. $SiX_2 < GeX_2 < PbX_2 < SnX_2$

4. $SiX_2 < GeX_2 < SnX_2 < PbX_2$

QUESTION

In SiF_6^{2-} and $SiCl_6^{2-}$, which one is known and why?

H.W

1. SiF_6^{2-} because of small size of F
2. SiF_6^{2-} because of large size of F
3. SiF_6^{2-} because of small size of Cl
4. SiF_6^{2-} because of large size of Cl

Revise
Chemical Bonding

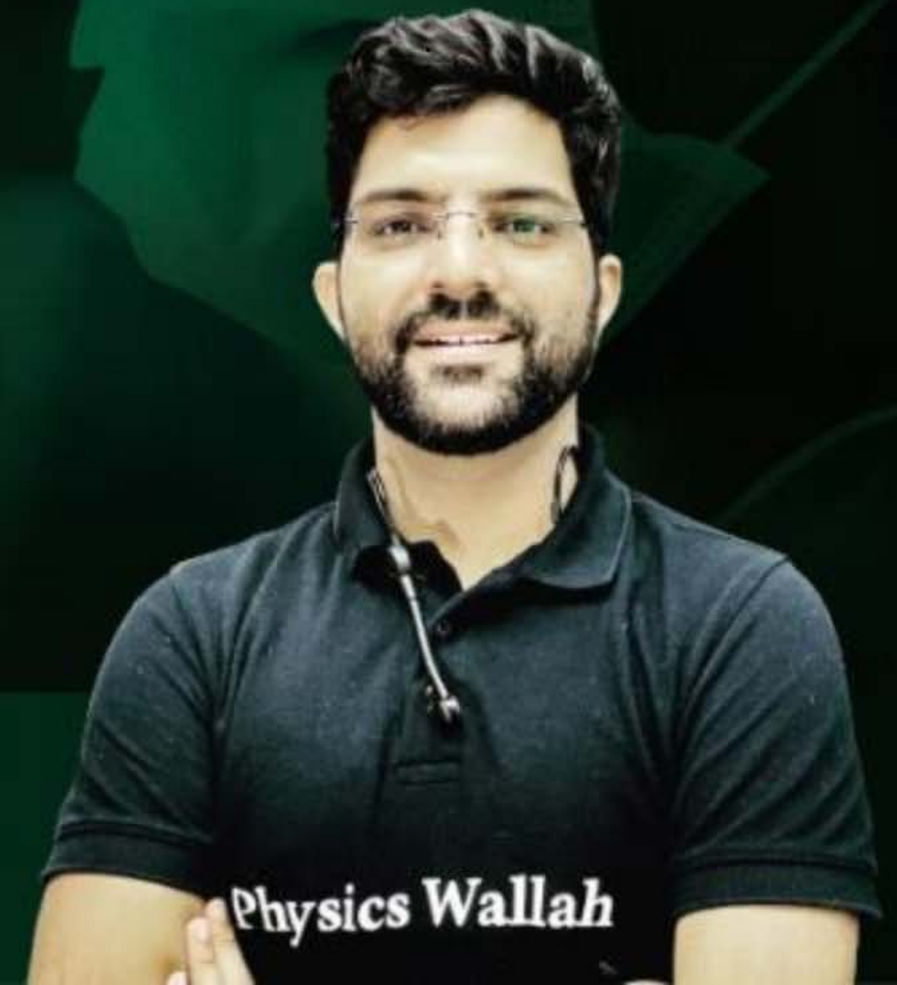
THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture - 01 | Inorganic Chemistry

SALT ANALYSIS



By - Mohit Dadheech (MD Sir)

Topics *to be covered*

1. Introduction.
2. gen. Solubility Rules.
3. Test of Anions (CO_3^{2-} & S^{2-})

NEET

Anions - CO_3^{2-}, S^{2-}, NO_2^-, Cl^-, Br^-, I^-, NO_3^-, SO_4^{2-}

Cations - Pb^{2+}, Cu^{2+}, Al^{3+}, Fe^{3+}, Ni^{2+}, Zn^{2+}, Ca^{2+}, Ba^{2+}, Mg^{2+}, NH_4^+

Introduction :-

Salt Analysis → Detection of anions & Cation From given mixture.
(Unknown Salt)

Salt

↓

Cation + Anion

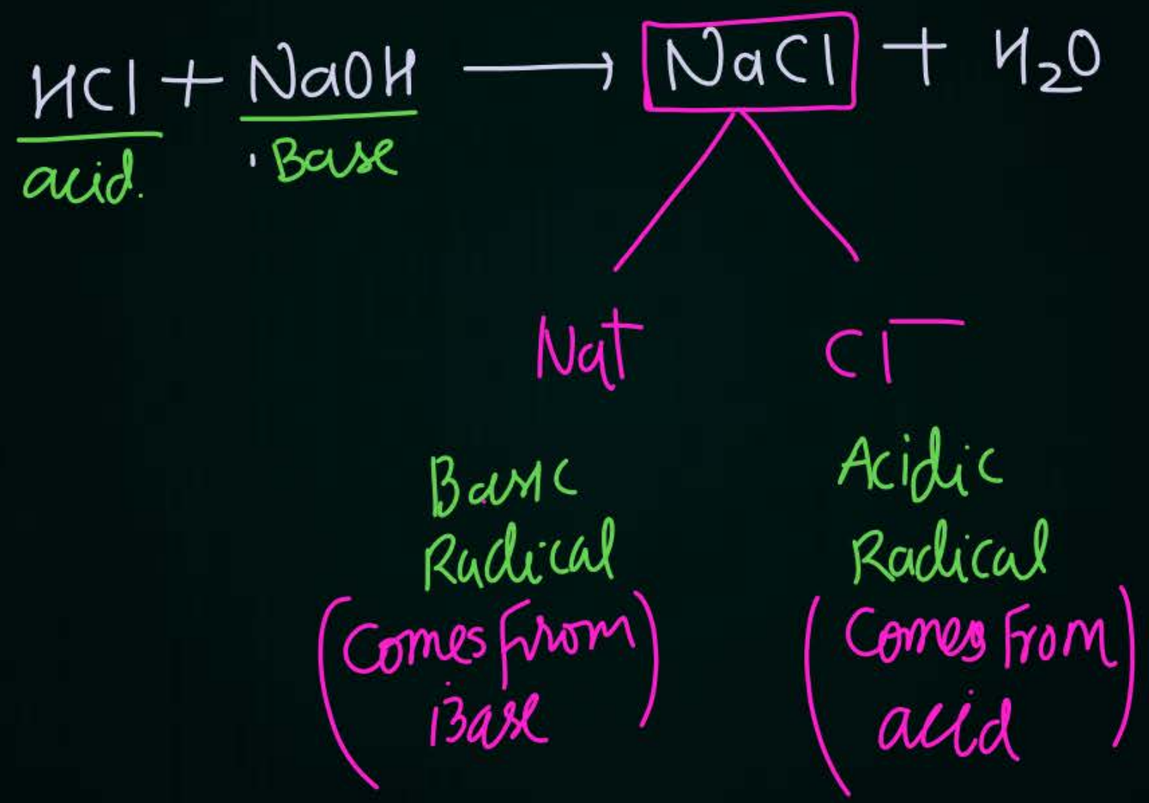
(M^+X^-)

Salt

M^+X^- ⟶ M^+ (Test of cations) → Basic Radical

X^- (Test of Anions) → acidic Radical.

(Salt ⇒ Acid + Base)



NOTE during Salt Analysis Anions are identified before Cations.

Reason Because Some anions are Interfering radicals. Can affect the test of Cations

If Interfering anions are present then they must be removed by Suitable methods.

Interfering anions

Fluoride	Borate	Oxalate	Arsenate	Silicate	Phosphate
F^-	BO_3^{3-}	$C_2O_4^{2-}$	AsO_4^{3-}	SiO_3^{2-}	PO_4^{3-}
Fir	Bola	(OX) OX	Aise	Seekho	Fatafat

Test of Anions

- (Primary)
  - Preliminary test
  - Confirmatory test.

Classification of Anions :-

Anions

- Class- A → give Volatile Product with Acids. (gas)
- Class- B → do not give Volatile Product with Acids (gas)

Class A

→ Subgroup-1 → give Volatile product with dil H_2SO_4 / dil HCl

group Reagent

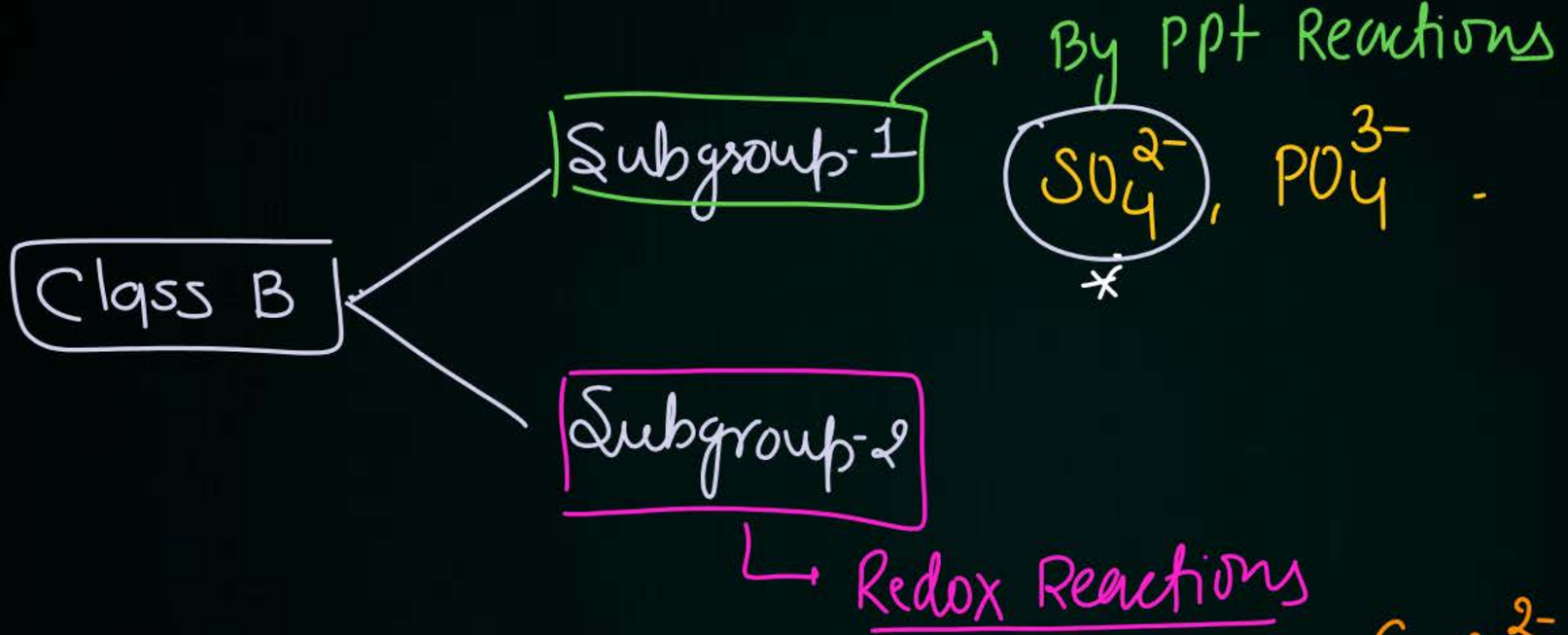
Ex CO_3^{2-}, S^{2-}, NO_2^- SO_3^{2-}, HCO_3^-, CH_3COO^-

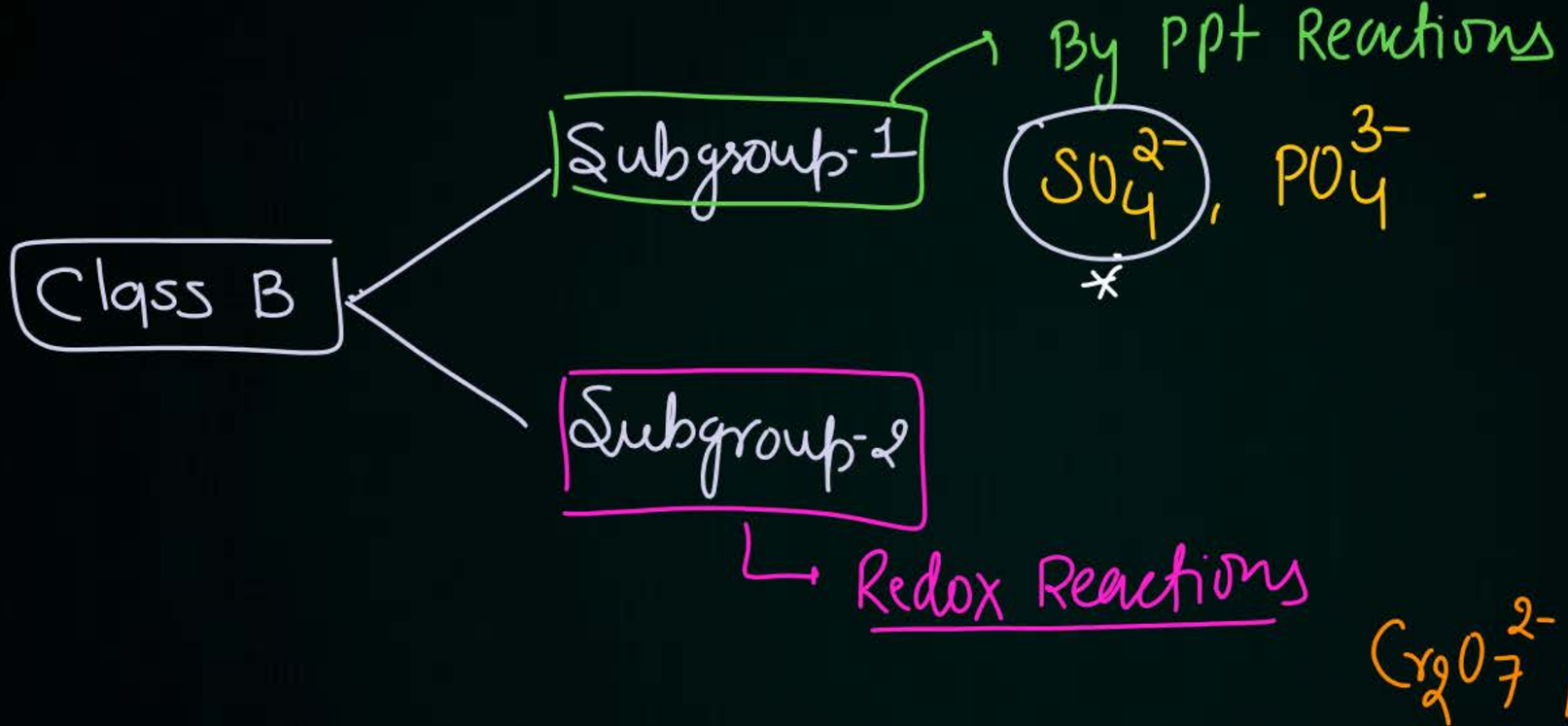
*

→ Subgroup-2 → give volatile product with Conc. H_2SO_4

group Reagent

* Cl^-, Br^-, I^-, NO_3^- F^-, $C_2O_4^{2-}$


Class B
Subgroup-1
By ppt Reactions
SO_4^{2-}, PO_4^{3-}.
Subgroup-2
Redox Reactions
$Cr_2O_7^{2-}$, MnO_4^- etc.


Class B
Subgroup-1
By ppt Reactions
SO_4^{2-}, PO_4^{3-}.
Subgroup-2
Redox Reactions
$Cr_2O_7^{2-}$, MnO_4^- etc.

Preliminary test For Class-A (Subgroup-1) Anions

dry Salt (s) $\xrightarrow{\text{dil HCl}}$ / $\xrightarrow[\text{or.}]{\text{dil } H_2SO_4}$

	Gas evolved	Possible Anion
Colourless, odourless Brisk effervescence which turns lime water milky. $CO_2 + Ca(OH)_2 \rightarrow CaCO_3\downarrow$	$CO_2\uparrow$	CO_3^{2-} Carbonate
Rotten egg like Smell. Which turns lead acetate fiter paper Black. $H_2S + Pb(CH_3COO)_2 \rightarrow PbS\downarrow$ Black.	$H_2S\uparrow$	S^{2-} Sulphide
Brown Colour gas Which turns acidified KI + stach solution Blue. [$NO_2 + KI + Starch + CH_3COOH \rightarrow$ Blue]	$NO_2\uparrow$	NO_2^- (Nitrite)

Preliminary test For Class-A (Subgroup-2) Anions

$$\text{dry Salt}_{(s)} + \text{C}\cdot H_2SO_4$$

Colourless pungent smell gas which gives white dense Fumes with glass rod dipped into NH_4OH	Reddish Brown gas Pungent smell Intensity of gas ↑se On addition of MnO_2 (O.A)	Violet Vapours Intensity of gas ↑se On addition of MnO_2 (O.A)	Brown gas Intensity of gas ↑se On addition of Cu turning & Solution becomes Blue
Gas Evolved ⇒ $HCl\uparrow$	$Br_2\uparrow$	$I_2\uparrow$	$NO_2\uparrow$
Possible Anions ⇒ Cl^-	Br^-	I^-	NO_3^-

$Br_2 + H_2O \longrightarrow$ Brown Colour.

$\overset{+4}{N}O_2 + H_2O \longrightarrow$ Colourless

$\overset{+2}{N}O + H\overset{+5}{N}O_3$

Imp Rxn

Pani mai NO_2 (2, 5) ho jata Hai

disproportionate

♀ Which of the following gives volatile product with dil H_2SO_4

(1) NaCl

(2) Na_2S

(3) KF

(4) K_2SO_4

Q.2 Salt (X) $\xrightarrow{\text{dil HCl}}$ Gas (Y)

If gas (Y) has rotten egg like smell then X & Y resp.

(H_2S)

(1) K_2SO_3, SO_2

(2) Na_2S, PH_3

(3) Na_2S, H_2S

(4) H_2S, Na_2S

Que

$NaX \xrightarrow{C.\ H_2SO_4} Y \xrightarrow{H_2O}$ Brown Solution

Y: Brown Vapours

$X = ?$ $\quad Y = ?$

Br^- $\quad Br_2$

Q Which of the following acidic radical can intefere with test of cation.

(1) CO_3^{2-}

(2) Br^-

(3) SO_3^{2-}

(4) $C_2O_4^{2-}$

Que Which salt remains Unaffected by $C.H_2SO_4$

(1) Na_2CO_3

(2) NaCl

(3) NaBr

(4) None of these.

$C.H_2SO_4$

↓

Subgroup-1

Subgroup-2

Reaction ✓

dil H_2SO_4

Only Subgroup 1

Confirmatory test For Anions :- (wet test)

dry Salt + H_2O →

- Soluble → Use this water extract directly for test
- Insoluble → Then make it Soluble First

Preparation of Sodium Carbonate Extract (Soda Extract)

1 Part Salt + 3 Part Na_2CO_3 + H_2O $\xrightarrow{\Delta}$ Solution $\xrightarrow{\text{Filteration}}$ Use Filtrate as Soda Extract

Soda Extract Preparation (For Anions)

* For Water Insoluble Salt.

M^+X^- + Na_2CO_3 → NaX + M_2CO_3

W/i Salt — W/s, W/i

* double decomposition Reaction

* Soda Extract Solution (Basic) is need to be neutralized before test (By the use of Suitable acids)

Filteration → (NaX in Filtrate)

S.B NaOH + W.A H_2CO_3

Na_2CO_3 (Basic) Bahot sara Hai Medium Basic Kyaa → Acid Mila Ke Neutral karo

Gen. Rules of Solubility

Data based (K_{sp})

K_{sp} ↑ → Solubility ↑

↓ K_{sp} Low → Solubility ↓se

Ppt Formation tendency ↑se

(1) * CO_3^{2-} → All CO_3^{2-} are (W/I)

Except Low ∅ & NH_4^+

(Na^+, K^+, Rb^+, Cs^+)

Li_2CO_3 → S.S

(2) SO_3^{2-} → Same as CO_3^{2-}

(3) HCO_3^- → All are W/S Except $NaHCO_3$

(due to H-Bonding) S.S

(4) HSO_3^- → Same as HCO_3^-

W/I water insoluble

W/S → water soluble

S.S → Sparingly soluble (Partial)

(5)* S^{2-} sulphide :-

All S^{2-} are W/I

Except S-Block IA & IIA and NH_4^+ → W/s sulphides

Most Insoluble

Very Low K_{sp}

HgS CuS PbS CdS Bi_2S_3 → Turant → PPt

Hg^{2+} Pb^{2+} Cu^{2+} Cd^{2+} Bi^{3+}

Hogi Punjabi Kudiya Seedhi Bindas

(6) OH^-

All OH^- are W/I Except Low K_{sp} & NH_4^+ & BSC → Ba Sr Ca (W/s)

Most insoluble → Al^{3+} Fe^{3+} Cr^{3+}

Aloo Fenka Karo

$Al(OH)_3$ $Fe(OH)_3$ $Cr(OH)_3$

* ⑦ NO_3^- & NO_2^- → All are W/s

* $AgNO_2$ → S-S

($AgNO_3$ W/s)

⑧ CH_3COO^- All are W/s

Except Ag^+ / Hg_2^{2+} / Cu_2^{2+}

Aaj Hoga Kyu.

* ⑨ SO_4^{2-}

All are W/s

Except 13 S C

Ba^{2+} Sr^{2+} Ca^{2+}

$BaSO_4$ $SrSO_4$ $CaSO_4$ } white ppt.

Ag^+ Hg_2^{2+} Pb^{2+}

any Hoga Prabhat.

* (10) $Cl^-/Br^-/I^-$ All are w/s

Except $Ag^+/Hg_2^{2+}/Pb^{2+}$] w/I

aay Hoga Prabhat

(11) NH_4^+ salts are w/s.

Special Case

$HgI_2 \rightarrow$ Red ppt

w/I Hg^{2+} But w/I

$Hg_2Cl_2 \rightarrow$ w/I

$HgCl_2 \rightarrow$ w/s

Hg^{2+} Hg_2^{2+} Hg^{2+}

Why HgI_2 is Insoluble

Reason I^- polarisability ↑ ⇒ compound covalent (Cov. ch ↑) ⇒ solubility in water ↓

Que Find w/s / wI (Home work)

(1) Cu_4S

(2) Ni_2S

(3) Na_2S

(4) $(NH_4)_2S$

(5) $Al(OH)_3$

(6) $Mg(OH)_2$

(7) $Cr(OH)_3$

(8) $Ba(OH)_2$

(9) NH_4OH

(10) $Ca(OH)_2$

(11) $Fe(OH)_3$

(12) $CuSO_4$

(13) Na_2SO_4

(14) Ag_2SO_4

(15) $PbSO_4$

(16) $BaSO_4$

(17) $NaNO_3$

(18) $AgNO_3$

(19) $Pb(NO_3)_2$

(20) $Pb(CH_3COO)_2$

(21) $Ag(CH_3COO)$

(22) $AgCl$

(23) $CaCl_2$

(24) Hg_2Cl_2

(25) HgI_2

(26) NH_4Cl

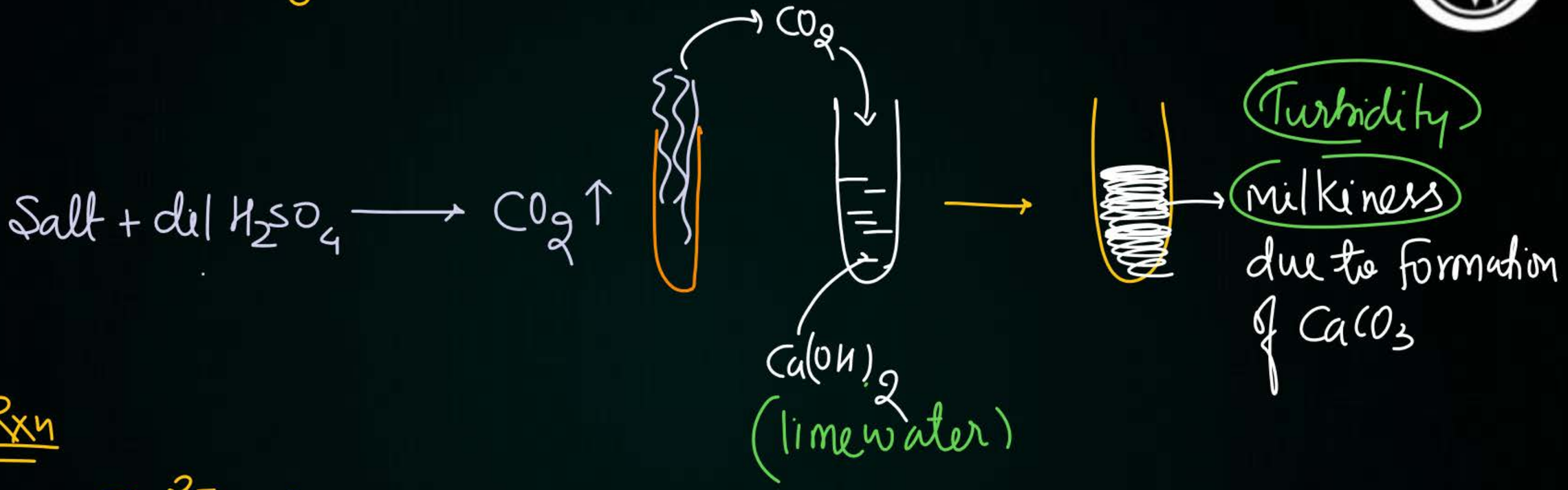
(27) $CaCO_3$

(28) $Ca(HCO_3)_2$

(29) $(NH_4)_2CO_3$

(30) $BaSO_3$

Confirmatory test For CO_3^{2-}



Rxn

$$CO_3^{2-} + \text{dil Acid} \longrightarrow CO_2$$

$$\underset{w/s}{CO_2} + \underset{}{Ca(OH)_2} \longrightarrow \underset{w/I}{CaCO_3} \downarrow$$

② ppt test

$CO_3^{2-} + BaCl_2 / CaCl_2 \longrightarrow$ $BaCO_3\downarrow / CaCO_3\downarrow$ White ppt

HCl / HNO_3

$BaCl_2 / CaCl_2$ or $Ba(NO_3)_2 / Ca(NO_3)_2$

W/s

W/s

③ Test with $AgNO_3$ → w/s

$$CO_3^{2-} + AgNO_3 \rightarrow Ag_2CO_3$$

(Pale yellow ppt)

- Boiling → Ag_2O ↓ Brown ppt
- HNO_3 → $AgNO_3$ Soluble
- HCl → AgCl ↓ white ppt
- Excess NH_3 → $[Ag(NH_3)_2]^+$ Soluble complex

Confirmatory tests For S^{2-} (Sulphide ions)

(i) Salt (S^{2-}) + dil HCl (or dil H_2SO_4) $\longrightarrow$ H_2S

- lead acetate Filter Paper $\longrightarrow$ $PbS\downarrow$ Black spot on paper.
- Cadmium acetate filter paper $\longrightarrow$ $CdS\downarrow$ yellow spot on paper

(ii) (Wet test) (V.Imp)

Soluble Salt + SNP $\longrightarrow$ Violet / Purple colour.

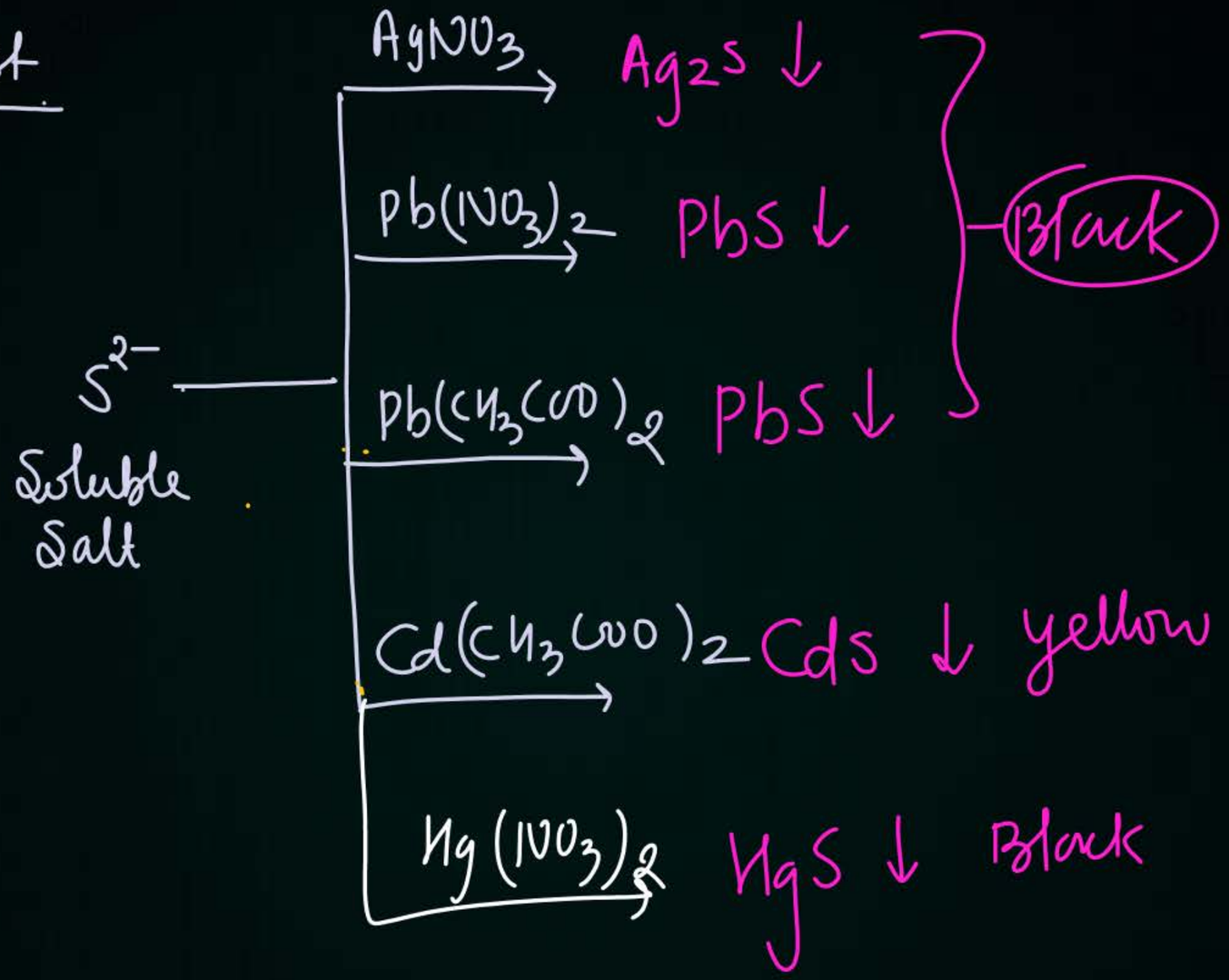
If insoluble then use Soda Extract

w/s

$Na_2S + Na_2[Fe(CN)_5NO] \longrightarrow Na_4[Fe(CN)_5NOS]$

Purple / Violet

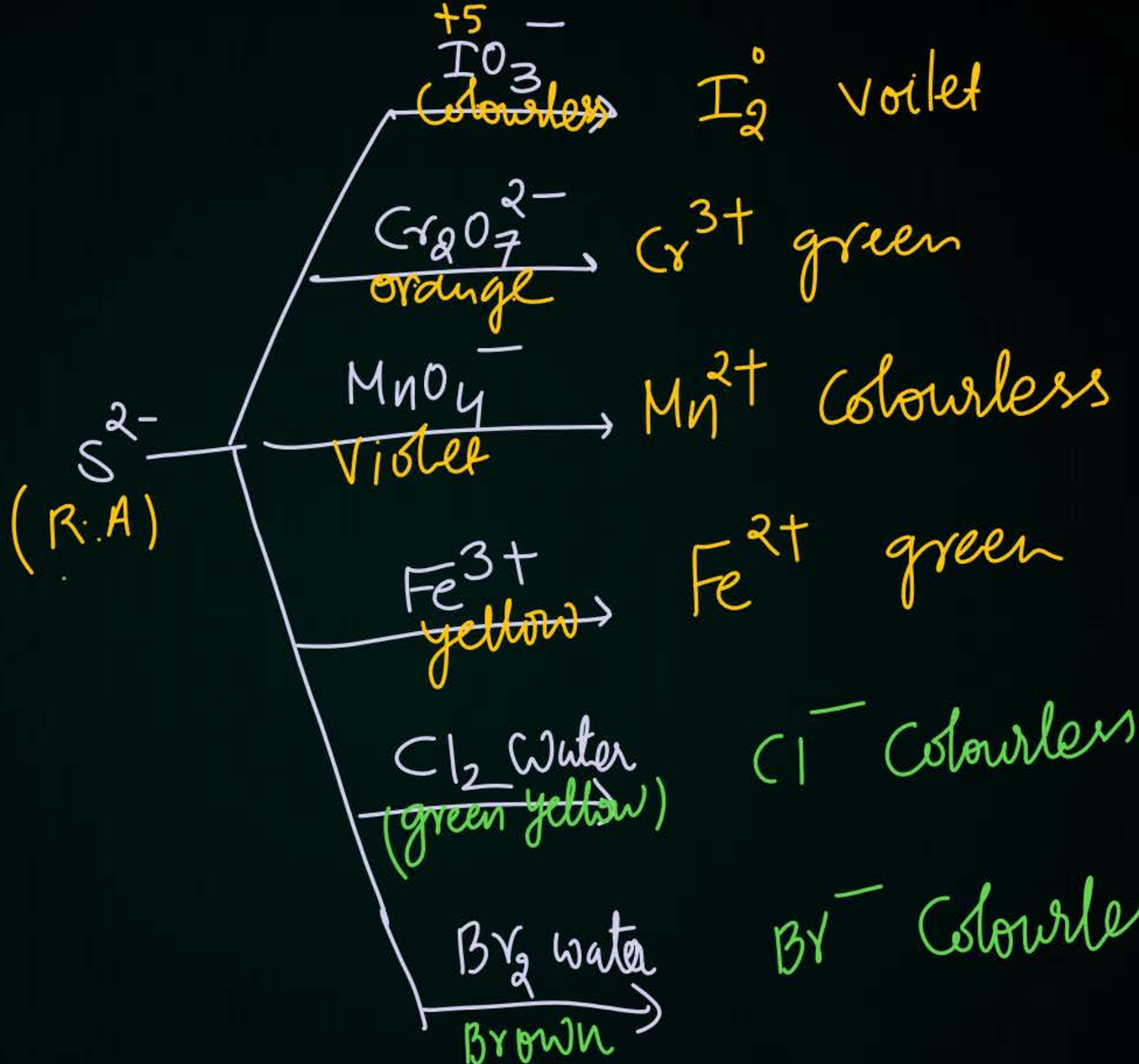
(iii) ppt test


S^{2-}
Soluble Salt
$AgNO_3$ → Ag_2S ↓
$Pb(NO_3)_2$ → PbS ↓
$Pb(CH_3COO)_2$ → PbS ↓
Black
$Cd(CH_3COO)_2$ → CdS ↓ yellow
$Hg(NO_3)_2$ → HgS ↓ Black

(iv) Redox test

S^{2-} ~~O.A~~

R.A ✓



THANK YOU

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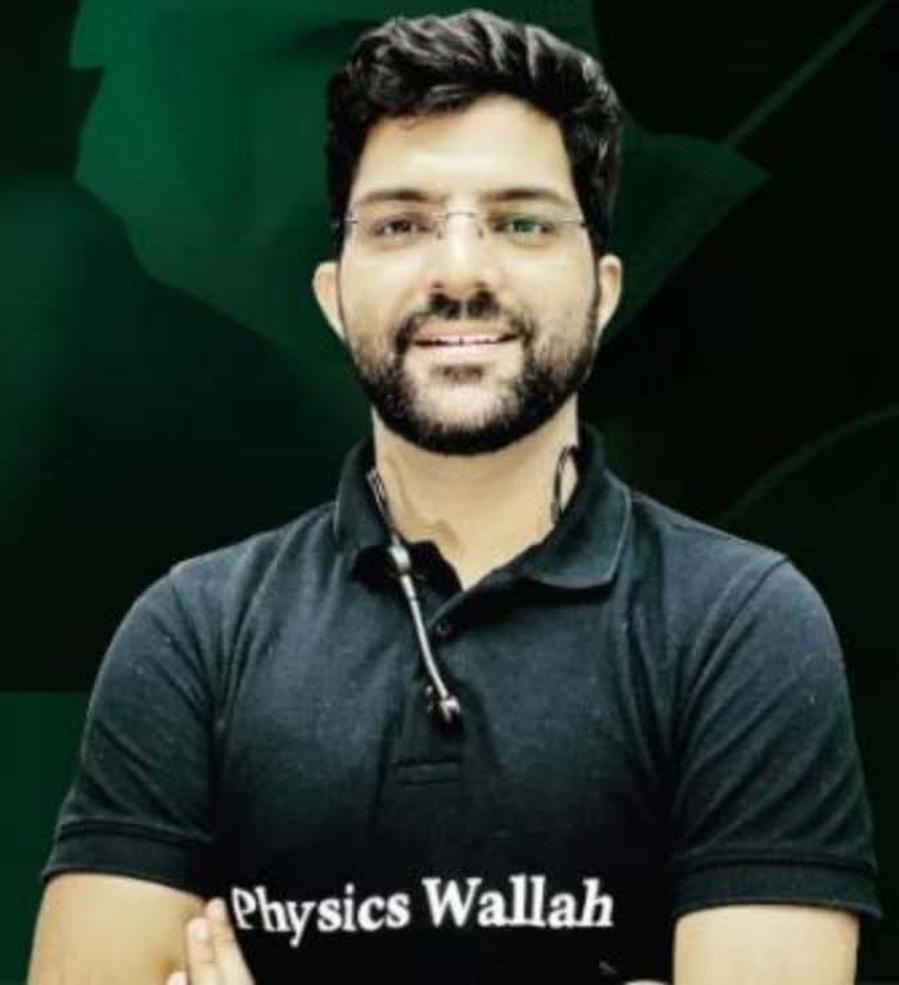
FOR NEET 2025

Lecture - 02 | Inorganic Chemistry

SALT ANALYSIS

By - Mohit Dadheech (MD Sir)



Topics *to be covered*

1. Test of Remaining Anions (NO_2^-, NO_3^-, Cl^-, Br^-, I^-, SO_4^{2-})
2.
3.

NEET

Anions - CO_3^{2-}, S^{2-}, NO_2^-, Cl^-, Br^-, I^-, NO_3^-, SO_4^{2-}

Cations - Pb^{2+}, Cu^{2+}, Al^{3+}, Fe^{3+}, Ni^{2+}, Zn^{2+}, Ca^{2+}, Ba^{2+}, Mg^{2+}, NH_4^+

Que Find w/s / wI (Homework) (Ans)

(1) Cu_4S w/i°

(2) NiS w/i°

(3) Na_2S w/s

(4) $(NH_4)_2S$ w/s

(5) $Al(OH)_3$ w/i°

(6) $Mg(OH)_2$ w/i°

(7) $Cr(OH)_3$ w/i°

(8) $Ba(OH)_2$ w/s

(9) NH_4OH w/s

(10) $Ca(OH)_2$ w/s

(11) $Fe(OH)_3$ w/i°

(12) $CuSO_4$ w/s

(13) Na_2SO_4 w/s

(14) Ag_2SO_4 w/i°

(15) $PbSO_4$ w/i°

(16) $BaSO_4$ w/i°

(17) $NaNO_3$ w/s

(18) $AgNO_3$ w/s

(19) $Pb(NO_3)_2$ w/s

(20) $Pb(CH_3COO)_2$ w/s

(21) $Ag(CH_3COO)$ w/i°

(22) AgCl w/i°

(23) $CaCl_2$ w/s

(24) Hg_2Cl_2 w/i°

(*25) HgI_2 w/i°

(26) NH_4Cl w/s

(27) $CaCO_3$ w/i°

(28) $Ca(HCO_3)_2$ w/s

(29) $(NH_4)_2CO_3$ w/s

(30) $BaSO_3$ w/i°

Confirmatory test for NO_2^-

(A) Acid test

NO_2^- + H^+ → HNO_2 → NO + HNO_3

Salt + dil H_2SO_4 → Unstable

NO + O_2 (From Air) → NO_2 ↑

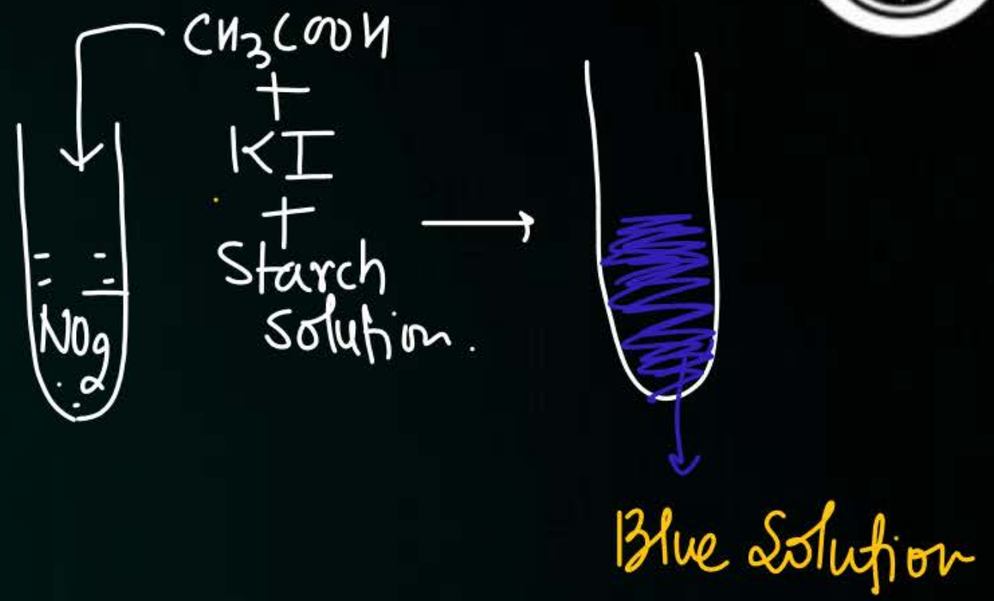
Brown fumes.

(B) $NO_2^- + CH_3COOH \xrightarrow{H^+} HNO_2$

$\overset{+3}{H}\overset{+3}{N}O_2 + K\overset{-1}{I} \longrightarrow \overset{0}{I_2} + NO$

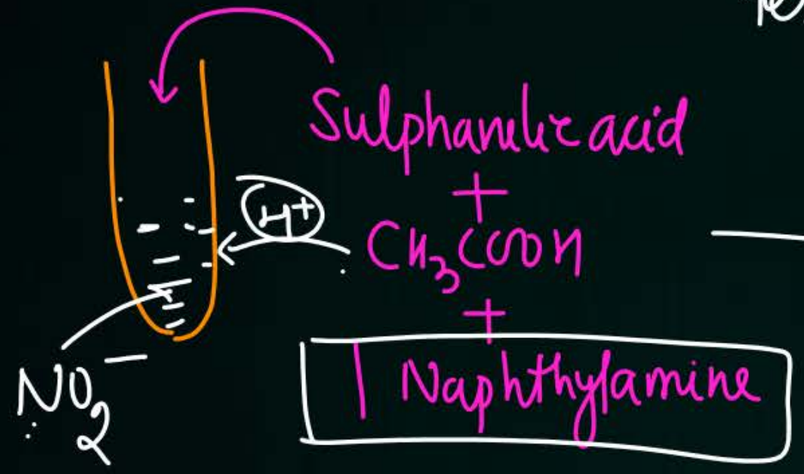
(O.A) $+CH_3COOH$

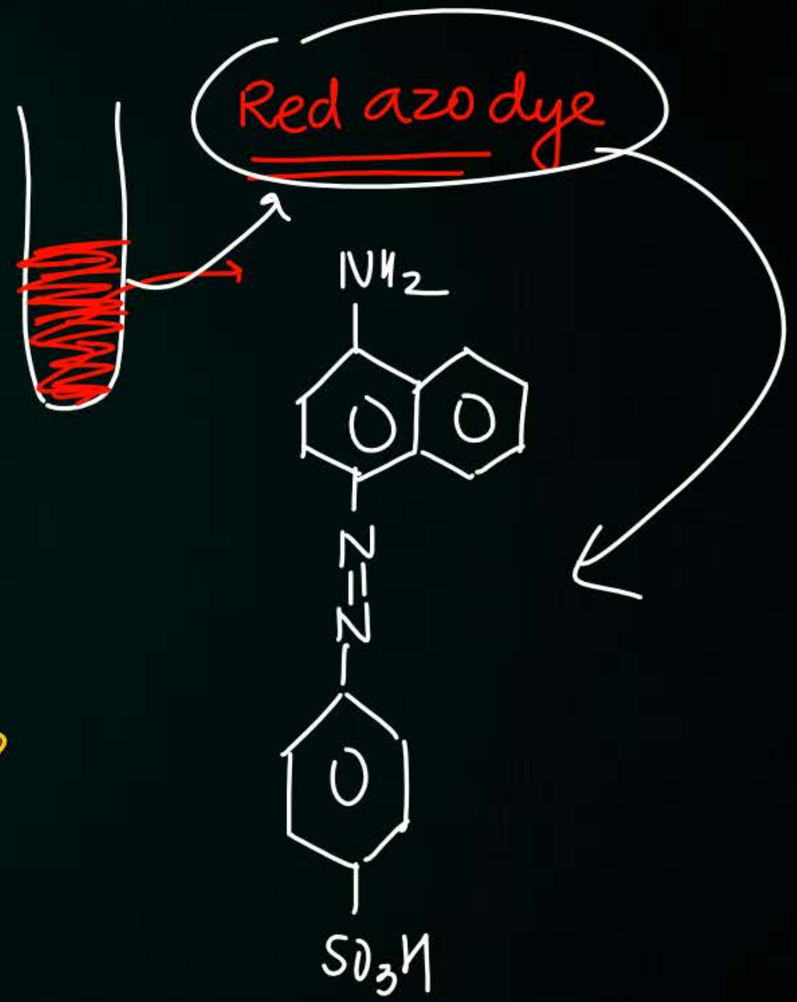
I_2 + Starch $\Rightarrow$ Blue Colour.

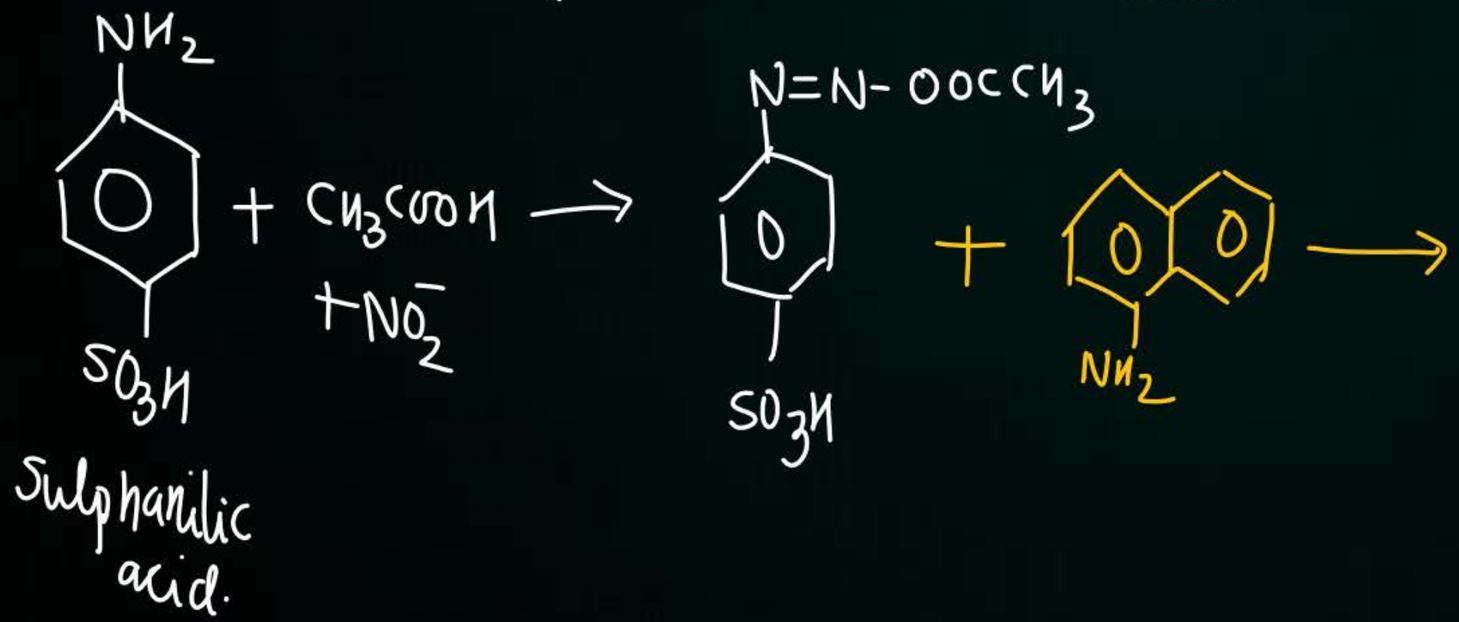


© Griss Ilosvay test

Sulphanilic acid + 1 napthylamin reagent test.







Confirmatory test for Subgroup-2 anions (NO_3^-, Cl^-, Br^-, I^-)

group Reagent → $C.H_2SO_4$

Test For NO_3^- (Nitrate ion)

(A) Acid test

$$NO_3^- + H^+ \xrightarrow[(C.H_2SO_4)]{\Delta} HNO_3$$

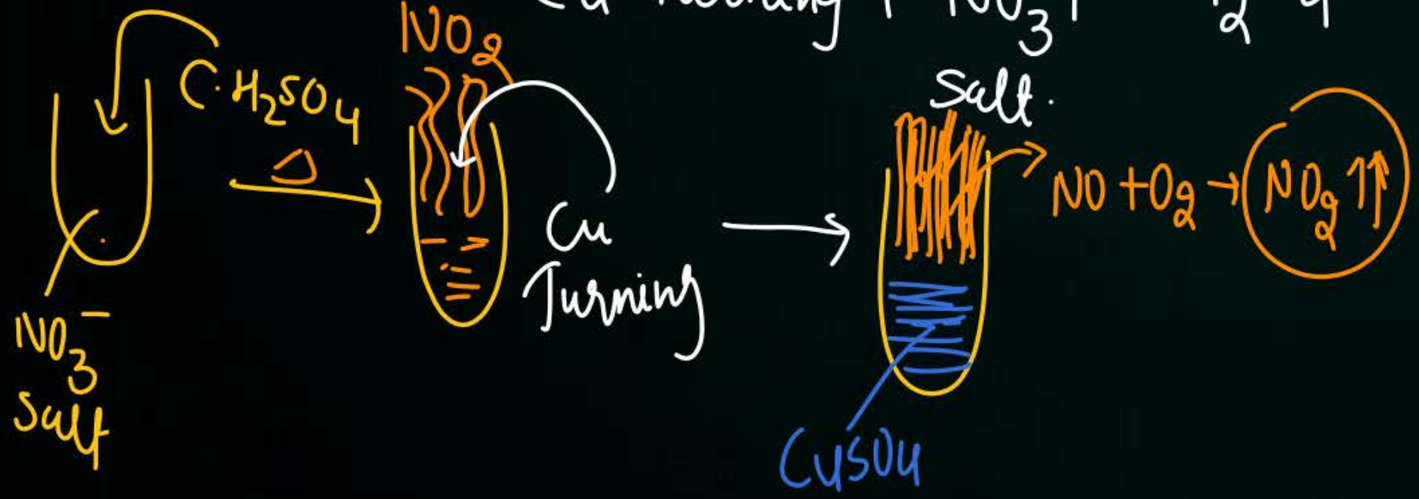
$$HNO_3 \xrightarrow{\Delta} \underline{NO_2} \uparrow + O_2 \uparrow$$

(Brown Fumes.)

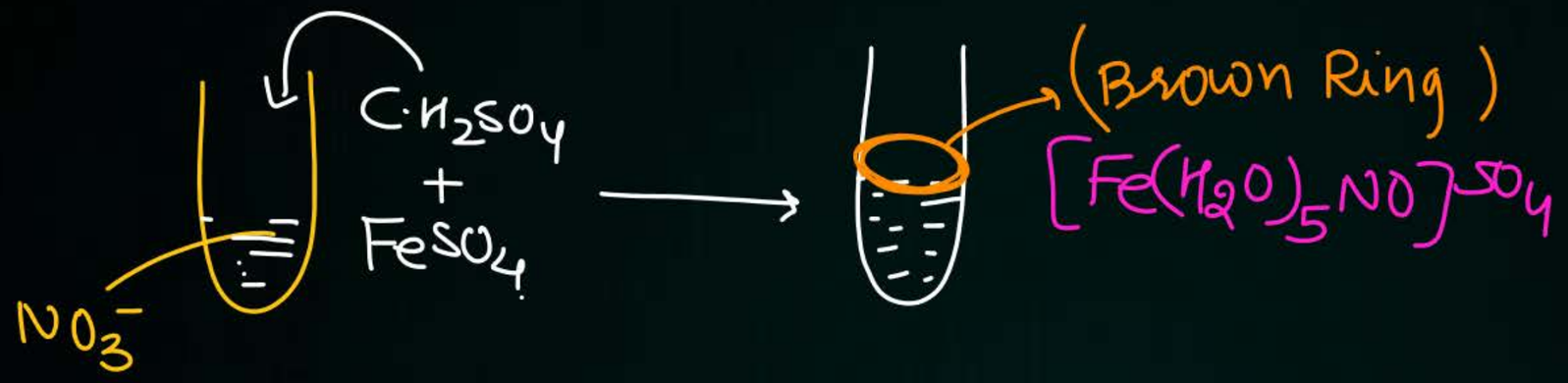
$$Cu \text{ turning} + NO_3^- + C.H_2SO_4 \longrightarrow CuSO_4 + NO \uparrow$$

$CuSO_4$ → Blue solution.

NO + O_2 (Air) → $NO_2 \uparrow$ Brown fumes



(8) Brown Ring test For NO_3^-



Reactions

$$NO_3^- + C.H_2SO_4 \longrightarrow HNO_3$$

(H^+)

* Key step For B.R test →

$$\overset{+5}{H}NO_3 + \overset{+2}{Fe}SO_4 \longrightarrow Fe^{3+} \quad SO_4^{2-} \rightarrow Fe_2(SO_4)_3 + \overset{+2}{NO}$$

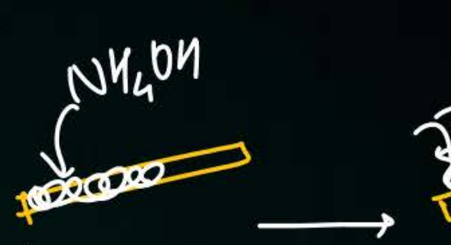
O.A (R.A)

NO: ligand

$$FeSO_{4(aq)} + NO \longrightarrow [Fe(H_2O)_5NO]SO_4$$

Brown Ring Complex.

Common test For Cl^-, Br^-, I^-



(A) Acid test

(1) $Cl^- + C.H_2SO_4 \longrightarrow HCl\uparrow$ ($HCl + NH_4OH \longrightarrow NH_4Cl$)

$Cl^- \xrightarrow[O.A]{MnO_2} Cl_2\uparrow$ green yellow.

(2) $Br^- + C.H_2SO_4 \xrightarrow[O.A]{} Br_2\uparrow$ Red Brown Vapour

on addition of MnO_2 (O.A) Intensity ↑se

③ $I^- + C{\cdot}H_2SO_4 \longrightarrow I_2 \uparrow$ Violet vapours

on addition of MnO_2

Intensity of Violet Vapour ↑se

(B) test with $AgNO_3$

$Cl^- + AgNO_3 \longrightarrow \overset{+1}{AgCl}\downarrow$ White ppt

- CN^- → $[Ag(CN)_2]^-$ soluble
- $S_2O_3^{2-}$ → $[Ag(S_2O_3)_2]^{3-}$ soluble
- Excess NH_3 → $[Ag(NH_3)_2]^+$ Soluble

$Br^- + AgNO_3 \rightarrow AgBr\downarrow$ Pale yellow ppt

- CN^- → $[Ag(CN)_2]^-$ soluble
- $S_2O_3^{2-}$ → $[Ag(S_2O_3)_2]^{3-}$ soluble
- Excess NH_3 → Partial soluble

$I^- + AgNO_3 \rightarrow AgI\downarrow$ yellow ppt

- CN^- → $[Ag(CN)_2]^-$ soluble
- $S_2O_3^{2-}$ → $[Ag(S_2O_3)_2]^{3-}$ soluble
- NH_3 Excess → Insoluble

(c) Test with $Pb(NO_3)_2$

$Cl^- + Pb(NO_3)_2 \longrightarrow PbCl_2\downarrow$ white → Soluble in warm water

$Br^- + Pb(NO_3)_2 \longrightarrow PbBr_2\downarrow$ yellow → Soluble in Hot water

$I^- + Pb(NO_3)_2 \longrightarrow PbI_2\downarrow$ yellow → Soluble in Boiling water

Extra

$AgCl < AgBr < AgI$ (Cov. ch)

Cov. ch ↑ solubility in polar solvent like H_2O & NH_3

↓se

Q Which of the Following is Soluble in Boiling water.

(1) PbI_2

(2) $PbCl_2$

(3) $PbBr_2$

(4) All of these.

Special test For Cl^- (Chromyl chloride test) (V. Imp)

given by Ionic chlorides only.

CCl_4 X
$CHCl_3$ X
CH_2Cl_2 X
$SiCl_4$ X

$HgCl_2$ X Covalent Ch.
$SnCl_4$ X (- u -)

$SnCl_2$ ✓
KCl ✓
$CaCl_2$ ✓
NaCl ✓

$PbCl_2 < PbCl_4$ (Cov. Ch.)
$SnCl_2 < SnCl_4$ (Cov. Ch.)

Chromyl chloride test

$Cl^- + conc.H_2SO_4 + \underset{(Solid)}{K_2\overset{+6}{Cr_2}O_7} \longrightarrow \underset{\text{(Chromyl chloride)}}{\overset{-1}{CrO_2Cl_2}}\uparrow$ (Red Brown vapour)

$CrO_2Cl_2 \xrightarrow{NaOH} \underset{\text{(Basic)}}{Na_2CrO_4}$ (yellow solution)

$Pb + NaOH$ (S.B) (Excess)

Ampho

$Na_2[Pb(OH)_4]$

Soluble

For removal of Extra NaOH

to avoid Reaction of Pb & NaOH

Part (a)

$Na_2CrO_4 \xrightarrow{CH_3COOH} (CH_3COO)_2Pb$

$(CH_3COO)_2Pb \longrightarrow PbCrO_4\downarrow$

yellow PPt

(Chrome yellow)

Part (B)

dil H_2SO_4 (Acidified) + Amyl Alcohol + H_2O_2

CrO_5 (Blue)

Layer test for Br^- / I^- ion :-

Based on oxidising power of Halogens ($F_2 > Cl_2 > Br_2 > I_2$)

(Halogen can oxidise Halides of higher atomic No.)

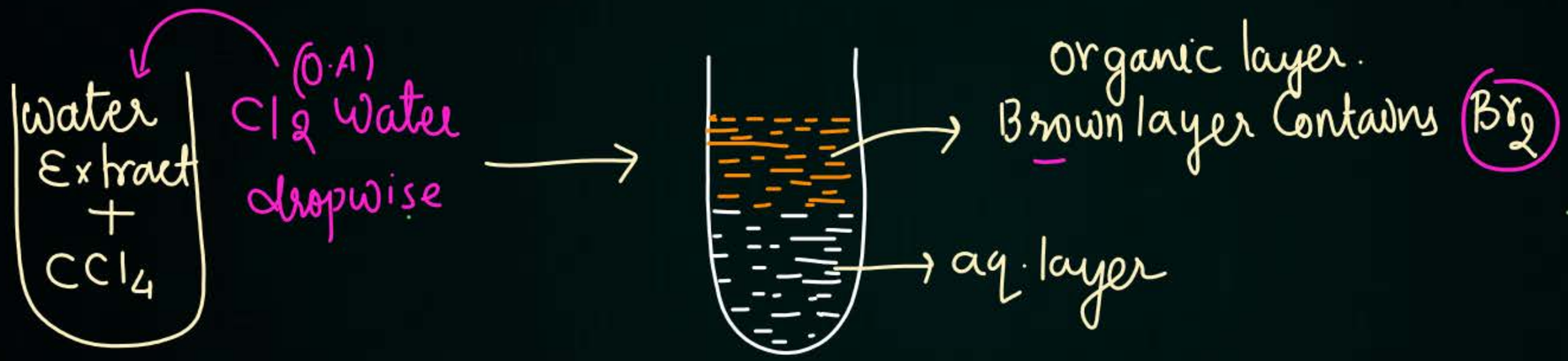
$$Br^- + Cl_2 \longrightarrow Cl^- + \underset{\text{Brown}}{Br_2}$$

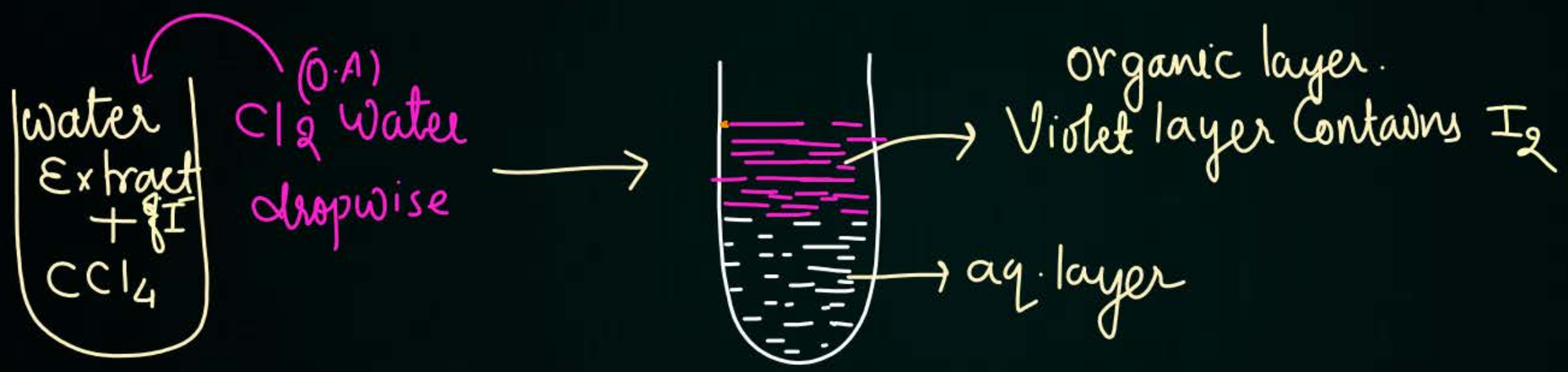
$$\underset{\text{NaBr}}{Na^+Br^-} + Cl_2 \rightarrow Na^+Cl^- + Br_2$$

$$I^- + Cl_2 \longrightarrow Cl^- + \underset{\text{Violet}}{I_2}$$

$$NaI + Cl_2 \longrightarrow NaCl + I_2$$

- Br_2 → Non polar → Soluble in Non polar solvent like CS_2, CH_2Cl_2, $CHCl_3$, * CCl_4
- I_2 → Non polar → Soluble in Non polar solvent like CS_2, CH_2Cl_2, $CHCl_3$, * CCl_4

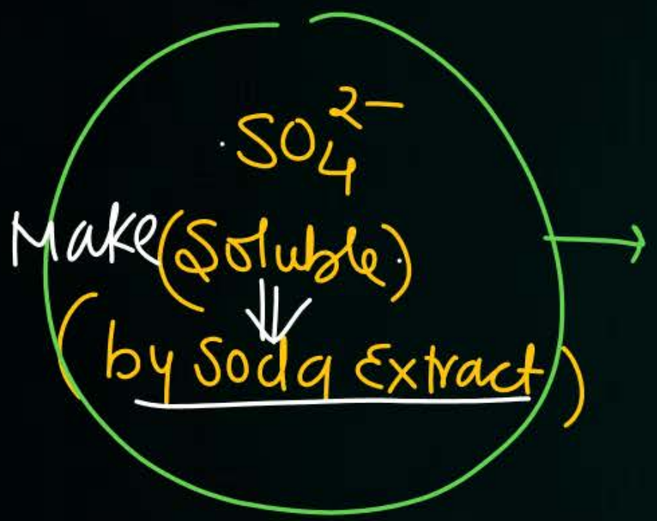

Water Extract + CCl_4
(0.A) Cl_2 Water dropwise
organic layer.
Brown layer Contains Br_2
aq. layer


(0.A)
Water
Extract
+ I
CCl4
Cl2 Water
dropwise
organic layer.
Violet layer Contains I2
aq. layer

Test For SO_4^{2-}

Class-B anion

(PPt Reactions)



$\rightarrow Na_2SO_4$

$BaCl_2 \rightarrow$ $BaSO_4 \downarrow$ White ppt

Insoluble in C. HNO_3 & C. HCl

$(CH_3COO)Pb \rightarrow$ $PbSO_4 \downarrow$ White ppt

Test for Cations

Test for Cations

Dry Test → Flame Used

- Flame test
- Borax Bead test
- Charcoal cavity and Cobalt nitrate charcoal cavity test

Wet Test

Preparation of original solution (0.5)

In which salt becomes soluble

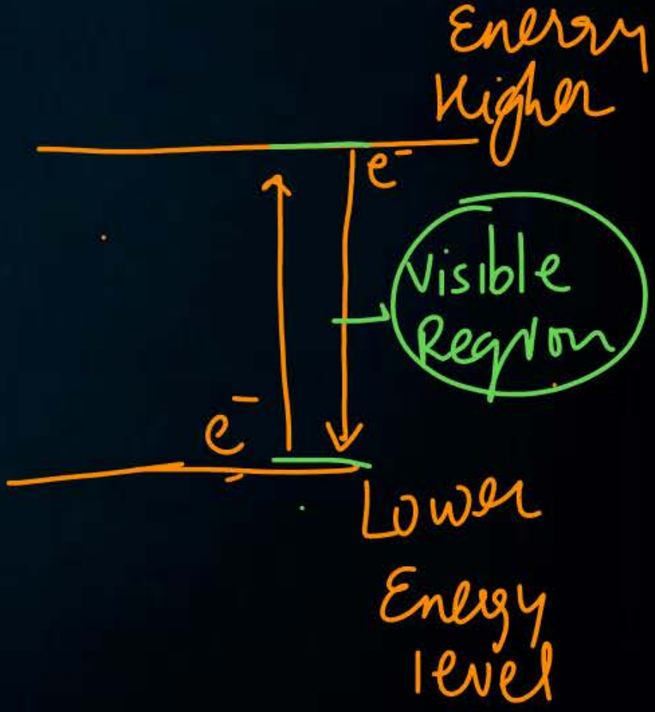
(gen)

Flame test : For s-block salts

Li	Crimson Red.
Na	golden yellow.
K	Violet.
Rb	Red Violet.
Cs	Blue.

Be, Mg → do not give Flame test (due to High I.E)

* Ca	Brick Red
Sr	Crimson Red.
* Ba	Apple green.



THANK YOU

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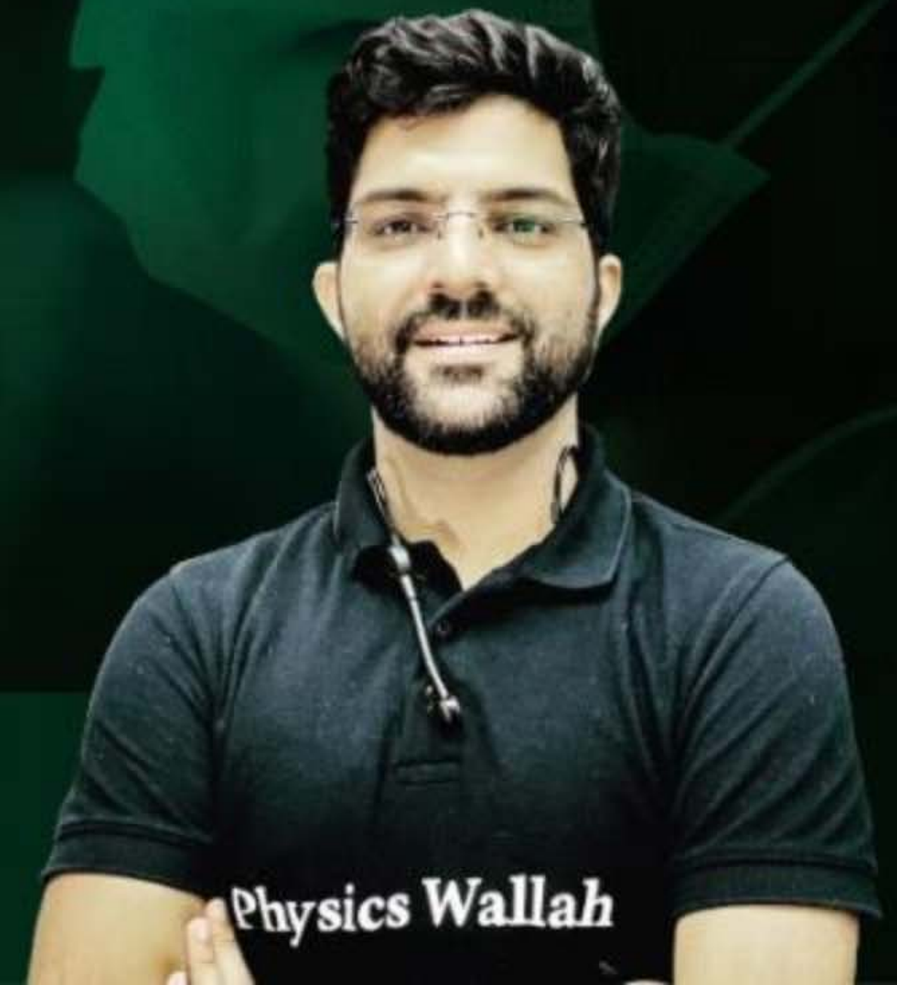
Lecture - 03 | Inorganic Chemistry

SALT ANALYSIS



By - Mohit Dadheech (MD Sir)

Topics *to be covered*

1. Test of Cations.
2.
3.

NEET

Anions - CO_3^{2-}, S^{2-}, NO_2^-, Cl^-, Br^-, I^-, NO_3^-, SO_4^{2-}

Cations - Pb^{2+}, Cu^{2+}, Al^{3+}, Fe^{3+}, Ni^{2+}, Zn^{2+}, Ca^{2+}, Ba^{2+}, Mg^{2+}, NH_4^+

Test of Cations

Dry test

(i) Colour observation

(ii) Heating effect

(iii) Flame test ✓

(iv) Borax Bead test

(v) phosphate bead test

(vi) Charcoal Cavity test

(vii) Cobalt Nitrate charcoal cavity test.

Wet test

Sample is used in the form of Solution

(Original Solution)

O.S

① Colour observation

(Churan (Salt) ka Colour)

Table 7.6 : Characteristic colours of some metal ions

Colour	Cations Indicated
Light green, Yellow, Brown	Fe^{2+}, Fe^{3+}
Blue	Cu^{2+}
Bright green	Ni^{2+}
Blue, Red, Violet, Pink	Co^{2+}
Light pink	Mn^{2+}

(2) Direct Heating of Salt

Heating of Salt in Clean & Dry test tube.

Table 7.7 : Inferences from the colour of the salt in cold and on heating

Colour when cold	Colour when hot	Inference
Blue	White	Cu^{2+}
Green	Dirty white or yellow	Fe^{2+}
White	Yellow	Zn^{2+}
Pink	Blue	Co^{2+}

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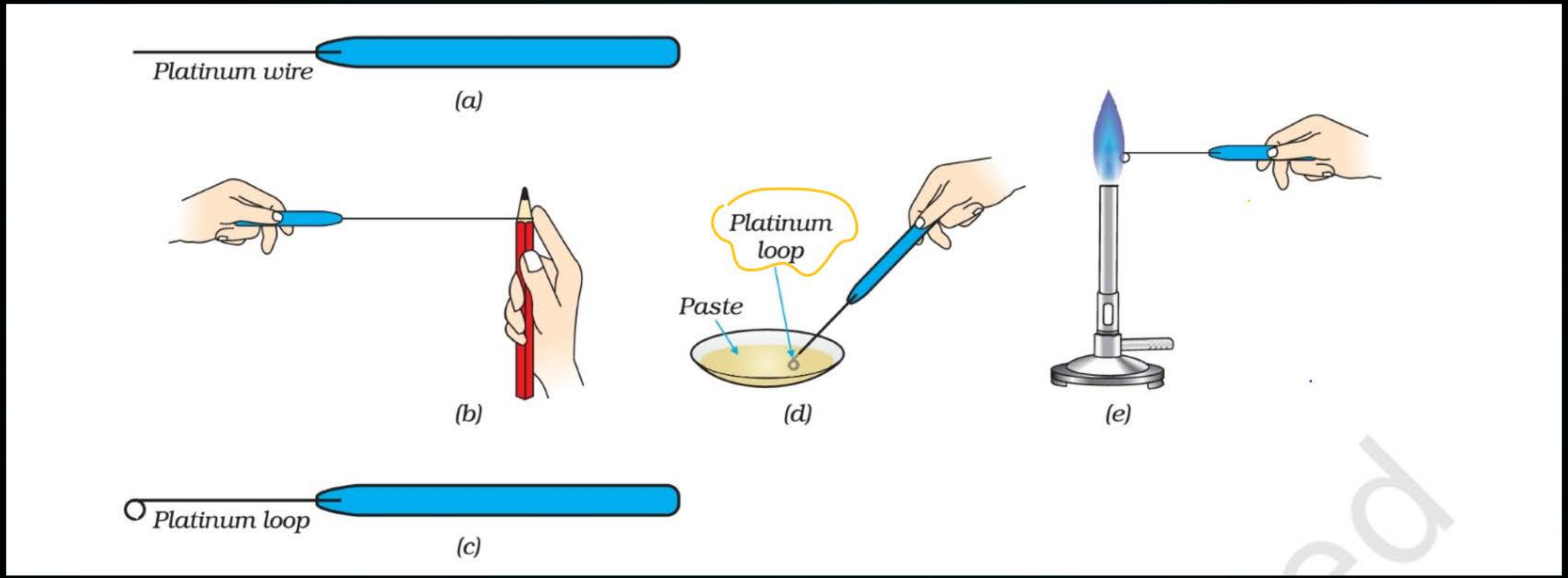
③ Flame test :-

(Last Lec. Notes)
(Colours)

Add in Last Lec. NOTES

Cu^{2+} → green Flame with Blue centre.



(4) Borax Bead Test

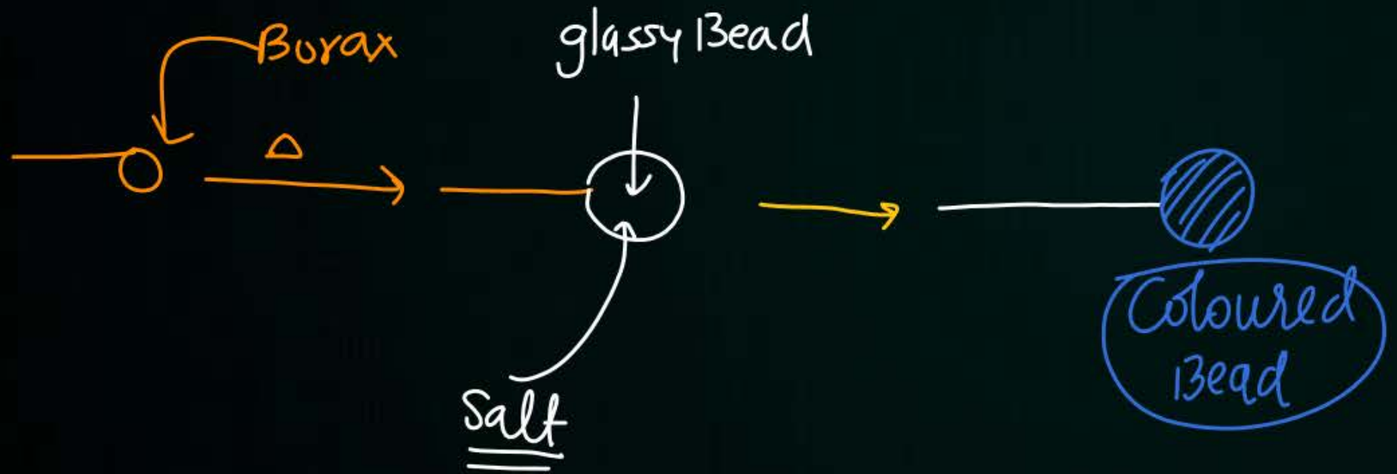
Borax → $Na_2B_4O_7 \cdot 10H_2O$

Boric oxide or Boric anhydride

Sodium Metaborate

$$Na_2B_4O_7 \cdot 10H_2O \xrightarrow{\Delta} Na_2B_4O_7 \xrightarrow{\Delta} \boxed{NaBO_2 + B_2O_3}$$

Transparent glassy Bead.

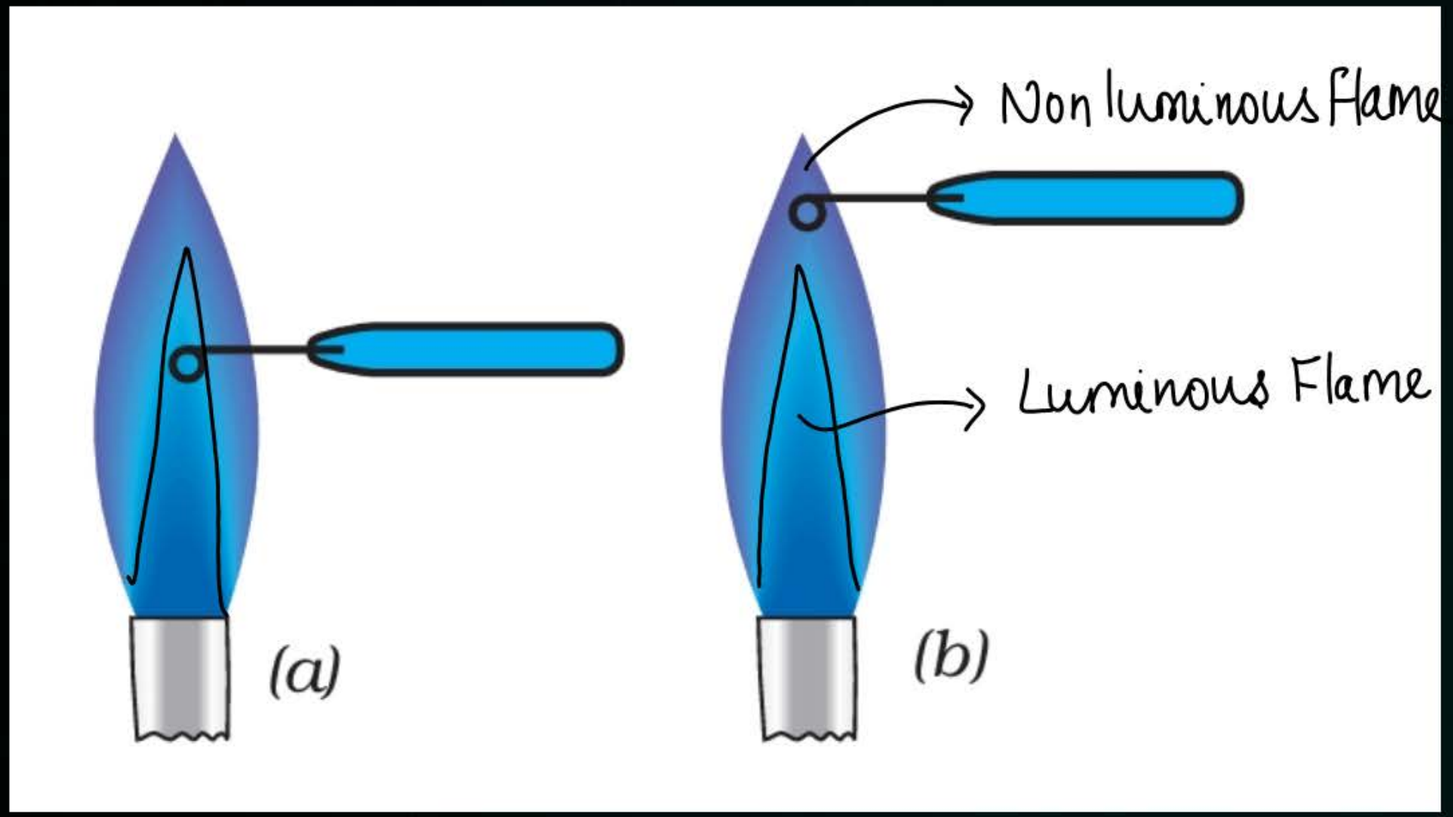


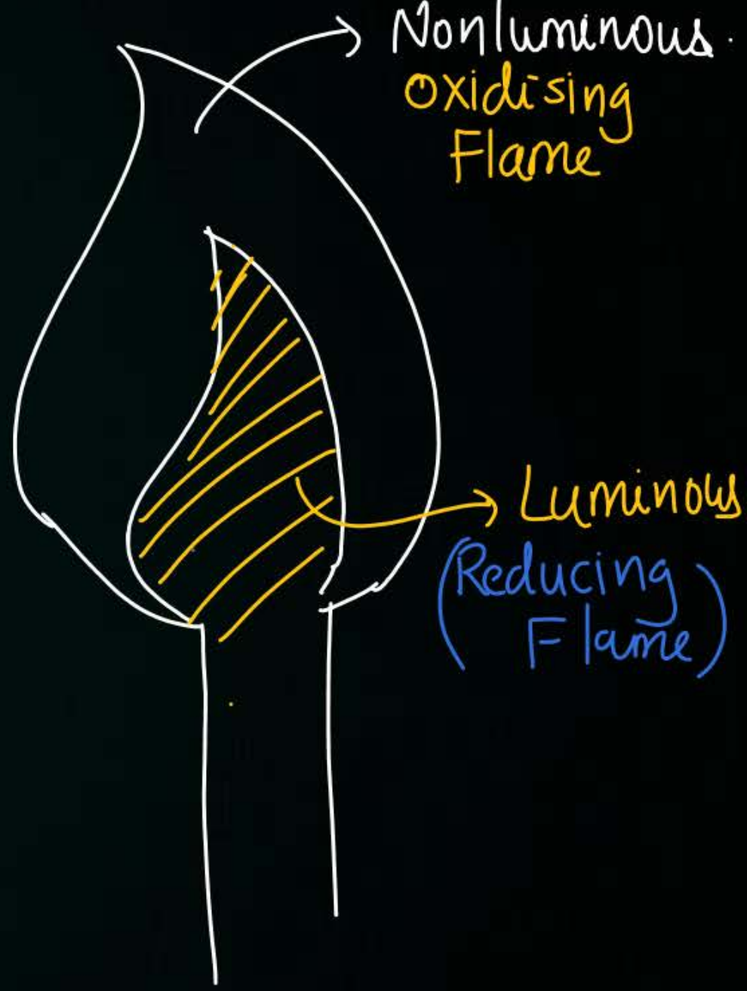
(Sample Salt)

Coloured Metaborates

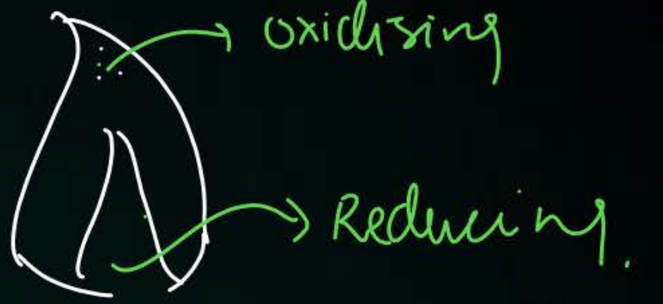
Ex $Cr(BO_2)_3$ green

$Co(BO_2)_2$ Blue.


(a)
Non luminous Flame
Luminous Flame
(b)


Non luminous
oxidising
Flame
Luminous
(Reducing
Flame)

Colours in Borax Bead test :-



Heating in oxidising (non-luminous) flame		Heating in reducing (luminous) flame		Inference
Colour of the salt bead		Colour of the salt bead		
In cold	In hot	In cold	In hot	
Blue	Green	Red opaque	Colourless	Cu^{2+}
Reddish brown	Violet	Grey	Grey	Ni^{2+}
Light violet	Light violet	Colourless	Colourless	Mn^{2+}
Yellow	Yellowish brown	Green	Green	Fe^{3+}

Cr^{3+} → green ✓

Co^{2+} → Blue ✓

⑤ Phosphate Bead test (Microcosmic Salt)

$NaNH_4HPO_4 \cdot 4H_2O$

(Sod. ammonium Hydrogen phosphate)

$\xrightarrow{\Delta}$ $NaPO_3 + NH_3\uparrow + H_2O\uparrow$

Sodium Metaphosphate

Bead + Salt → Coloured Metaphosphate

Colours will be same as Borax Bead test

H_3PO_4

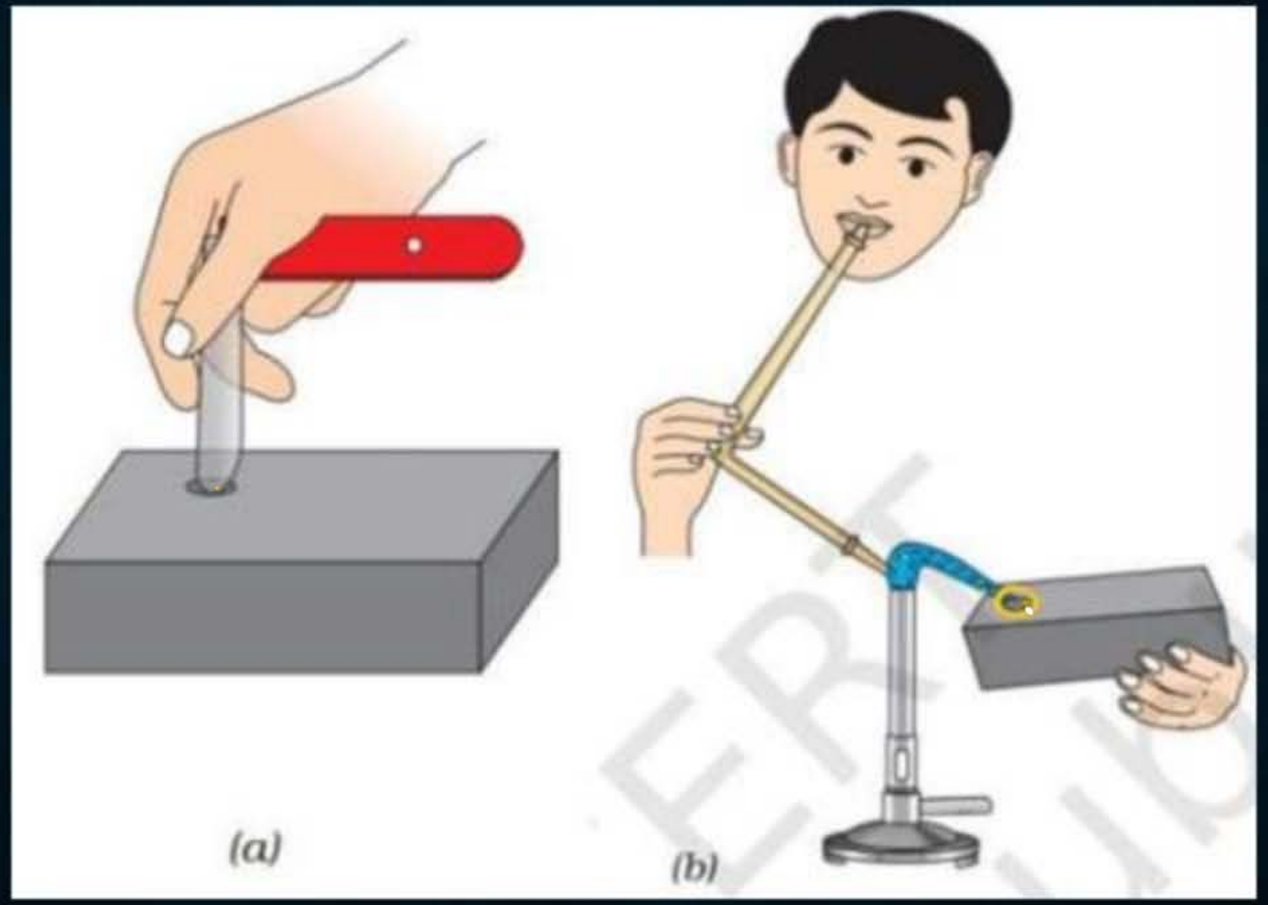
Phosphoric acid

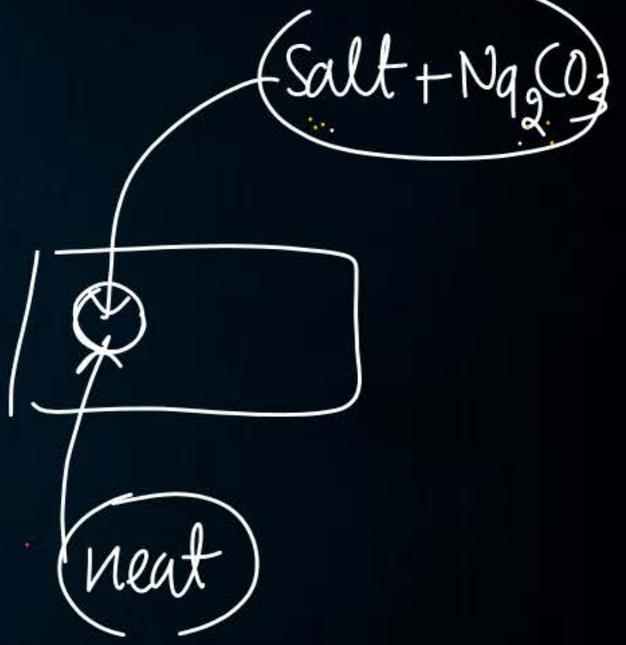
$\downarrow -2H^+$

HPO_4^{2-}

Hydrogenphosphate ion

(6) Charcoal Cavity test :- (Salt + Na_2CO_3 in cavity)





$$\text{Salt} + Na_2CO_3 \xrightarrow{\Delta} \underline{\text{Metal oxide}}$$

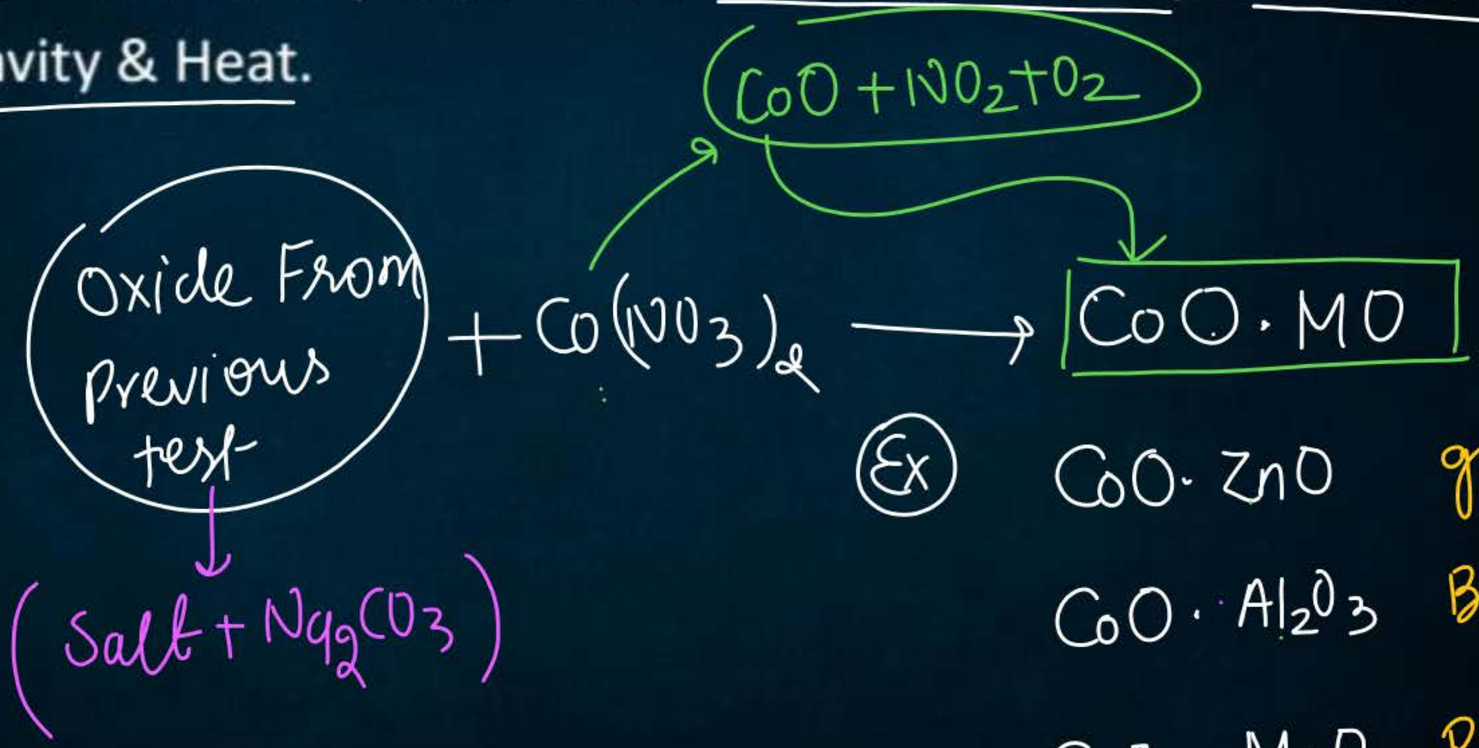
(Colour observation)

Table 7.10 : Inference from the charcoal cavity test

Observations	Inference
Yellow residue when hot and grey metal when cold	Pb^{2+}
White residue with the odour of garlic	As^{3+}
Brown residue	Cd^{2+}
Yellow residue when hot and white when cold	Zn^{2+}

(7) Cobalt nitrate charcoal cavity test :

If white residue is obtained in previous test then add 2-3 drops of $Co(NO_3)_2$ solution to that cavity & Heat.



(Ex)

$CoO \cdot ZnO$ green

$CoO \cdot Al_2O_3$ Blue

$CoO \cdot MgO$ Pink.

Janabe Gadi
Ali Bangla.
Mange Pinky.

Wet test for cations

Preparation of original solution (O.S)

(i) Dry salt + cold water → If soluble then taken as O.S.

(ii) Dry salt + hot water → If soluble then taken as O.S.

(ii) Dry salt + dil. HCl → If soluble then taken as O.S.

(iv) Dry salt + conc. HCl → If soluble then taken as O.S.

(v) Dry salt + dil. HNO_3 → If soluble then taken as O.S.

(vi) Dry salt + aqua regia → If soluble then taken as O.S.

(HCl : HNO_3
3 : 1)

O.S

↓

Jo ghul Jaye
Vahi O.S

Classification of cation (on the Basis of Ksp Values / Solubility)

Ksp ↓ se Solubility ↓ se

Group I	Aaj Ag^{+}	Hoga Hg_2^{2+}	Prabhat Pb^{2+}		
Group II IIA	Mogi Hg^{2+}	Punjabi Pb^{2+}	Kudiyaan Cu^{2+}	Seedhi Cd^{2+}	Bindas Bi^{3+}
Group II IIB	Aise As^{3+}/As^{+5}	Sab Sb^{3+}/Sb^{5+}	Tana-Tan Sn^{2+}/Sn^{4+}		
Group III	Al^{3+} Aloo	Fe^{3+} Fenka	Cr^{3+} Karo		
Group IV	Ni^{2+}	Co^{2+} NiCo	Mn^{2+}	Zn^{2+} Manjan	
Group V	Ba^{2+} Bharat	Sr^{2+}	Ca^{2+} Sarkar		
Group VI	Na^{+} Na	Mg^{2+} Mango	K^{+} Kar (Tax)		
Group 0	NH_4^{+} ammonium				

Grp.	Cations	Reagents	ppt and colours
I	Ag^{+}, Hg_2^{2+}, **Pb^{2+}**	dil HCl	AgCl, Hg_2Cl_2, $PbCl_2$ (White)
II	Hg^{2+}, **Pb^{2+}**, **Cu^{2+}**, Cd^{2+}, Bi^{3+} (IIA) As^{3+}/As^{+5}, Sb^{3+}/Sb^{5+}, Sn^{2+}/Sn^{4+} (IIB)	H_2S in P.O dil HCl (H_2S in acidic Medium)	PbS, CuS, Bi_2S_3 (Brownish Black), HgS (Black) CdS, As_2S_3, As_2S_5, SnS_2 (Yellow) SnS (Brown) Sb_2S_3, Sb_2S_5 (Orange)
III	**Al^{3+}**, **Fe^{3+}**, Cr^{3+}	NH_4OH in P.O NH_4Cl	$Al(OH)_3$ (White gel. ppt) $Fe(OH)_3$ Red brown $Cr(OH)_3$ (Green)
IV	**Ni^{2+}**, Co^{2+}, Mn^{2+}, **Zn^{2+}**	H_2S in P.O NH_4OH (H_2S in Basic Medium)	NiS, CoS (Black) ZnS (White) MnS (Buff/Flesh) (light Pink)
V	**Ba^{2+}**, Sr^{2+}, **Ca^{2+}**	$(NH_4)_2CO_3$ in P.O NH_4Cl	$BaCO_3$, $SrCO_3$, $CaCO_3$ (white)
VI	Na^{+}, **Mg^{2+}**, K^{+}	NO specific Reagent	
0	**NH_4^{+}**	—	

Flow Chart*

Original Solution

Dil.HCl

- **Precipitate, Group I** (Pb^{2+}) as chloride.
- **If no precipitate is formed** — Pass H_2S gas
  - **Precipitate, Group II** (Pb^{2+}, Cu^{2+}, As^{3+}) as sulphides
  - **If no precipitate, take original solution** — Heat (O.S.) with conc. HNO_3, cool and add solid NH_4Cl + NH_4OH solution in excess
    - **Precipitate, Group III** (Fe^{3+}, Al^{3+}) as hydroxides
    - **If no precipitate** — Pass H_2S
      - **Precipitate, Group IV** (Co^{2+}, Ni^{2+}, Mn^{2+}, Zn^{2+}) as sulphides
      - **If no precipitate, take original solution** — Add NH_4OH and solid $(NH_4)_2CO_3$
        - **Precipitate, Group V** (Ba^{2+}, Sr^{2+}, Ca^{2+}) as carbonates
        - **If no precipitate, take original solution to test Group VI,** Mg^{2+}

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Boil conc. HNO_3

H_2S + dil HCl

NH_4OH in P.O NH_4Cl

conc. HNO_3 O.A

$Fe^{2+} \rightarrow Fe^{3+}$

Fe^{3+} Fe^{2+}

Confirmatory test For group-I Cations Ag^+ Hg_2^{2+} Pb^{2+} *

O.S + dil HCl (G.R) → white ppt → $AgCl / PbCl_2 / Hg_2Cl_2$

Boiling →
- Soluble → $PbCl_2$ ✓
- Insoluble (Pb^{2+} absent) → $AgCl / Hg_2Cl_2$

$AgCl / Hg_2Cl_2$ → Excess $NH_3(aq)$ or NH_4OH

- Insoluble → Hg_2Cl_2 white ✓
- Soluble → Ag^+ ✓ → $[Ag(NH_3)_2]^+$

Hg_2Cl_2 white → On standing / Long time → Black ppt

After some time: $Hg_2Cl_2 + NH_4OH$ → $Hg^0 + Hg(NH_2)Cl$ (Black + white) → Black ppt

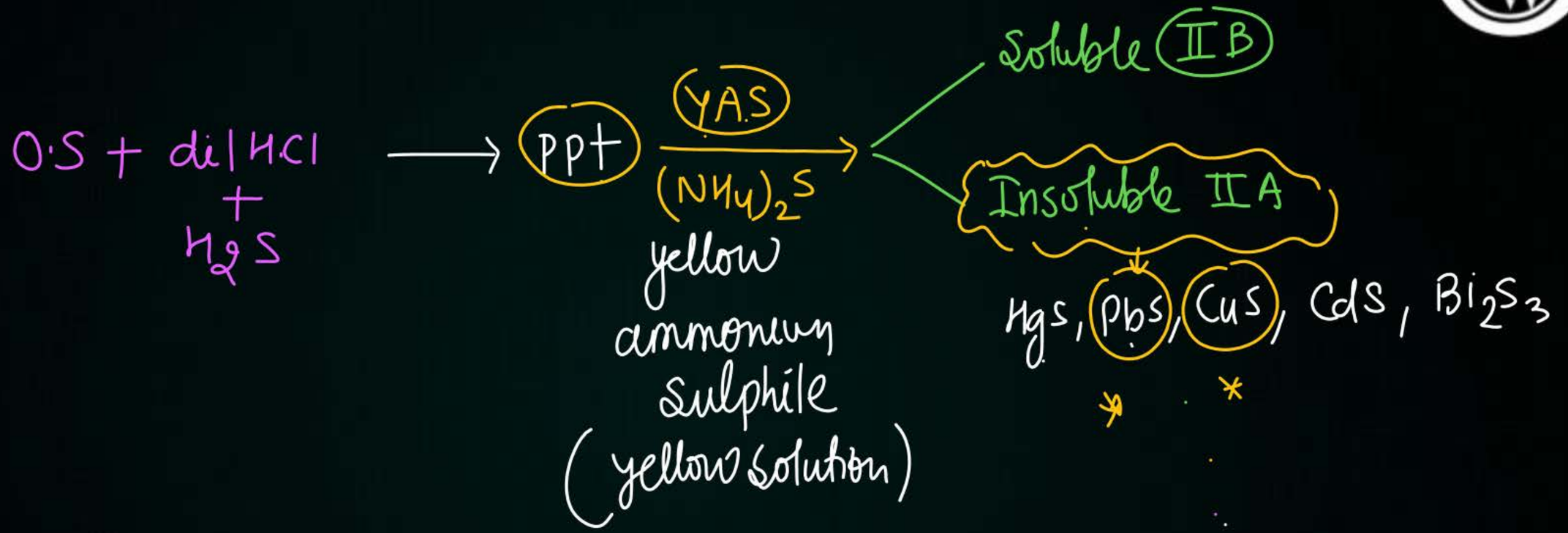
Overall

Test for Pb^{2+}

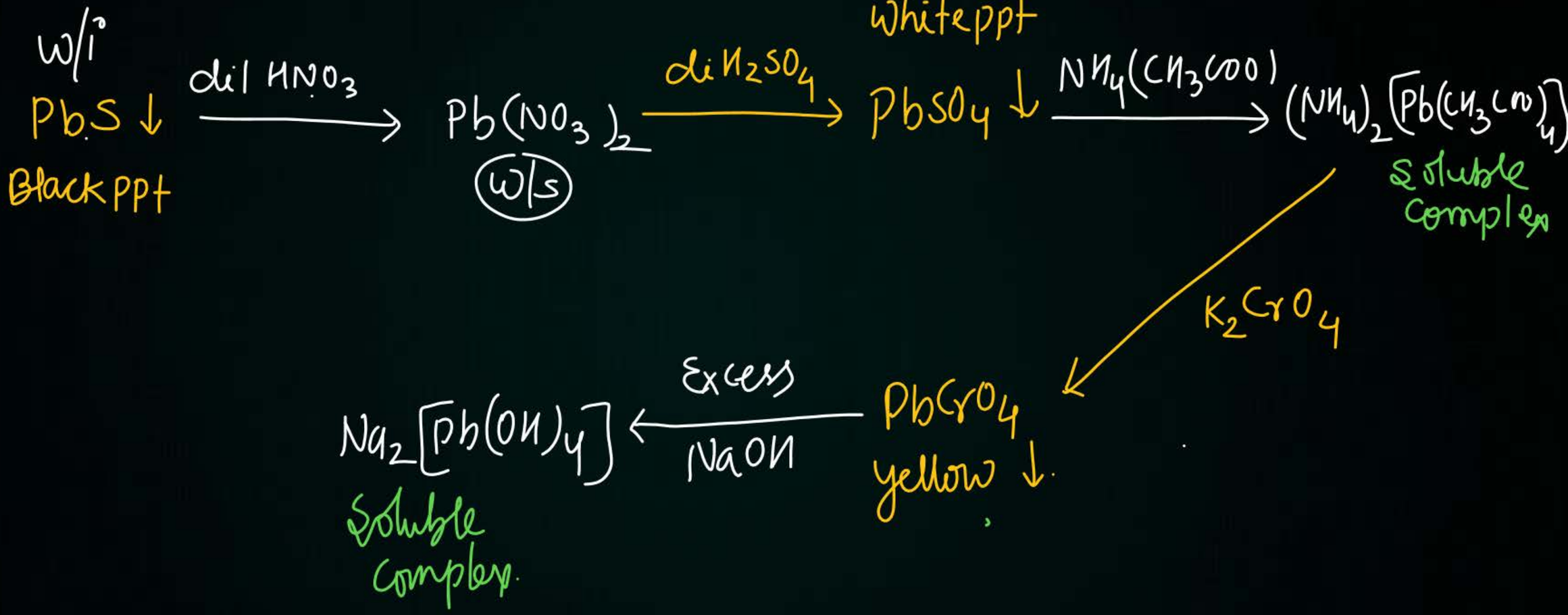
$PbCl_2$ (Hot solution) → soluble

* KI → $PbI_2\downarrow$ Yellow
* K_2CrO_4 → $PbCrO_4\downarrow$ yellow $\xrightarrow{NaOH\ (Excess)}$ $Na_2[Pb(OH)_4]$ (Soluble)
* H_2S → $PbS\downarrow$ Black.
* $dil.\ H_2SO_4$ → $PbSO_4\downarrow$ White. $\xrightarrow{NH_4(CH_3COO)}$ $(NH_4)_2[Pb(CH_3COO)_4]$ ammonium tetraacetato plumbate(II) (Soluble)
* KCN → $Pb(CN)_2\downarrow$ White

Test for group-II Cations (G.R) H_2S in p.o dil HCl



Test For Pb^{2+} (PbS)



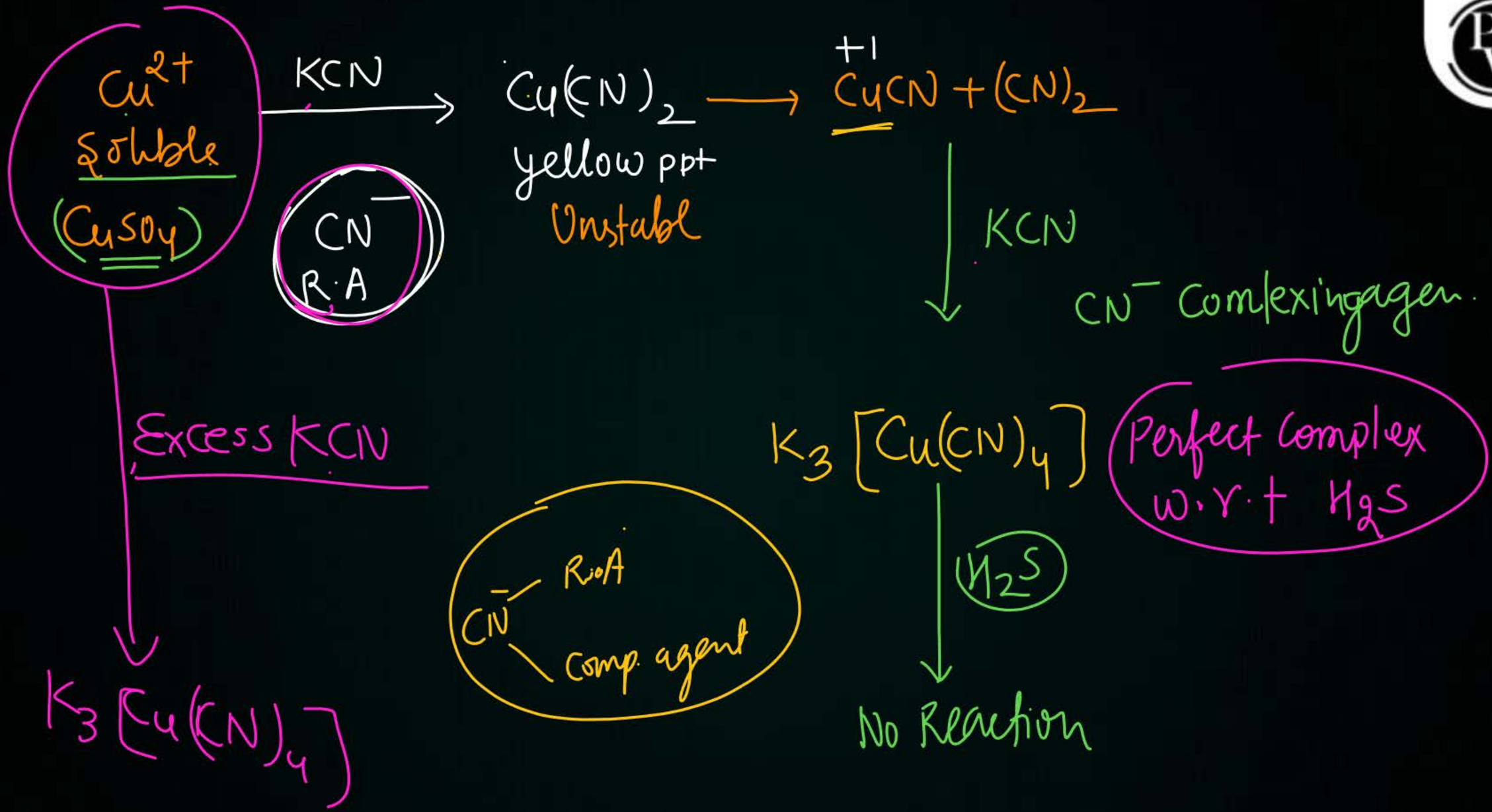
Test For Cu^{2+} ions

$Cu^{2+}S$ (Black ppt) $\xrightarrow{\text{dil } HNO_3}$ $Cu(NO_3)_2$ (Soluble) $\xrightarrow[\text{Long time}]{\text{Heating}}$ $CuSO_4$ (Blue Solution) $\xrightarrow[\text{less } NH_4OH]{}$ $Cu(OH)_2 \cdot CuSO_4 \downarrow$

Basic Copper Sulphate

Basic Copper Sulphate $\xrightarrow{\text{Excess } NH_4OH \text{ or } NH_3(aq)}$ $[Cu(NH_3)_4]SO_4$ (dsp^2, Sq. Planar Complex, deep Blue) $\xrightarrow{CH_3COOH}$ $CuSO_4$ (Blue Solution) $\xrightarrow{K_4[Fe(CN)_6]}$ $Cu_2[Fe(CN)_6] \downarrow$ Chocolate Brown ppt

$NH_3 + H^+ \rightarrow NH_4^+$ (ligand)


Cu^{2+}
Soluble
($CuSO_4$)
KCN
$Cu(CN)_2$
yellow ppt
Unstable
+1
$CuCN + (CN)_2$
KCN
CN^- Complexingagen.
CN^-
R.A
Excess KCN
$K_3[Cu(CN)_4]$
CN^-
R.A
Comp. agent
$K_3[Cu(CN)_4]$
Perfect Complex
w.r.t H_2S
H_2S
No Reaction

Test For group-III Cations

(G·R) NH_4OH in P·O NH_4Cl

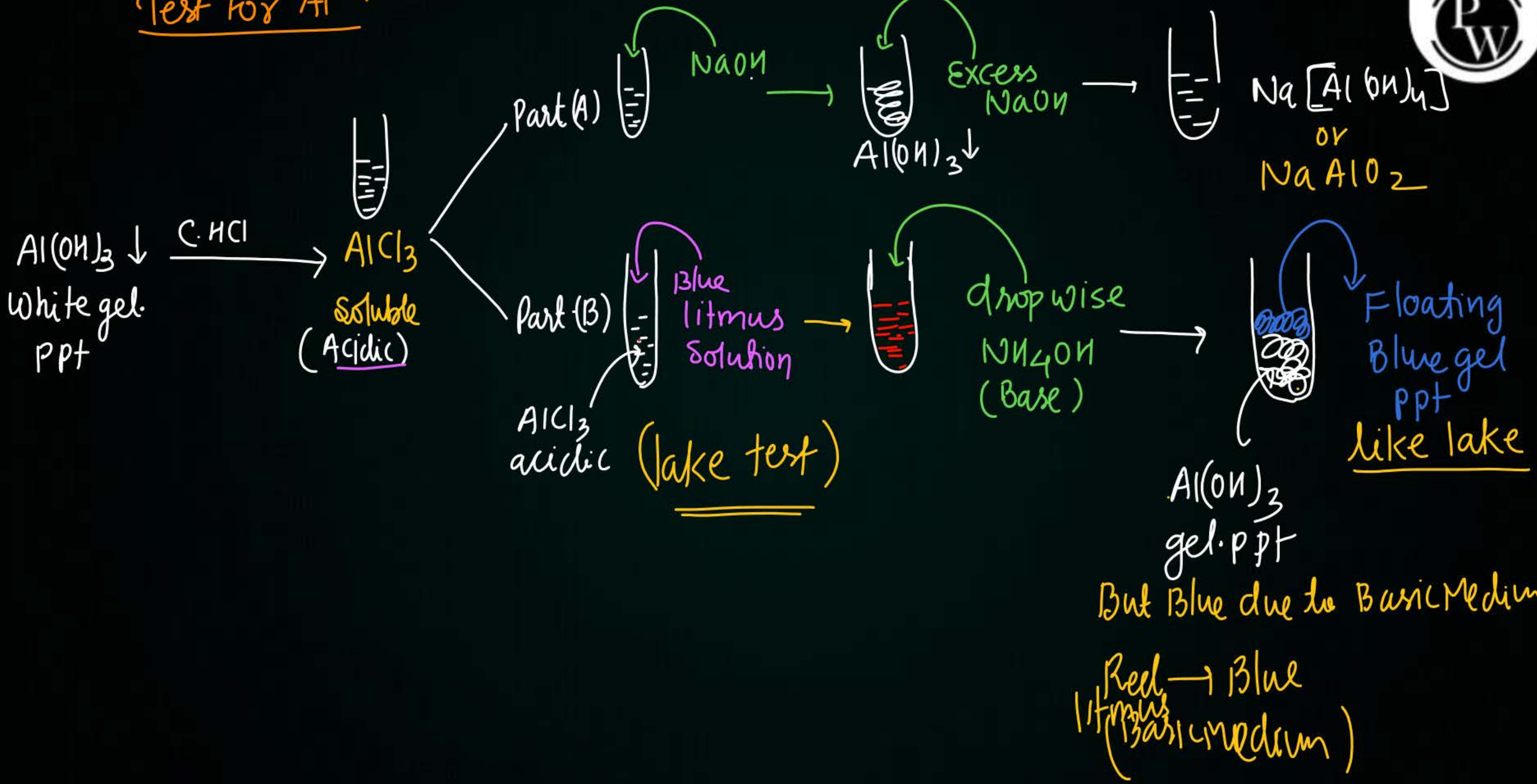
Al^{3+} Fe^{3+} Cr^{3+}

* *

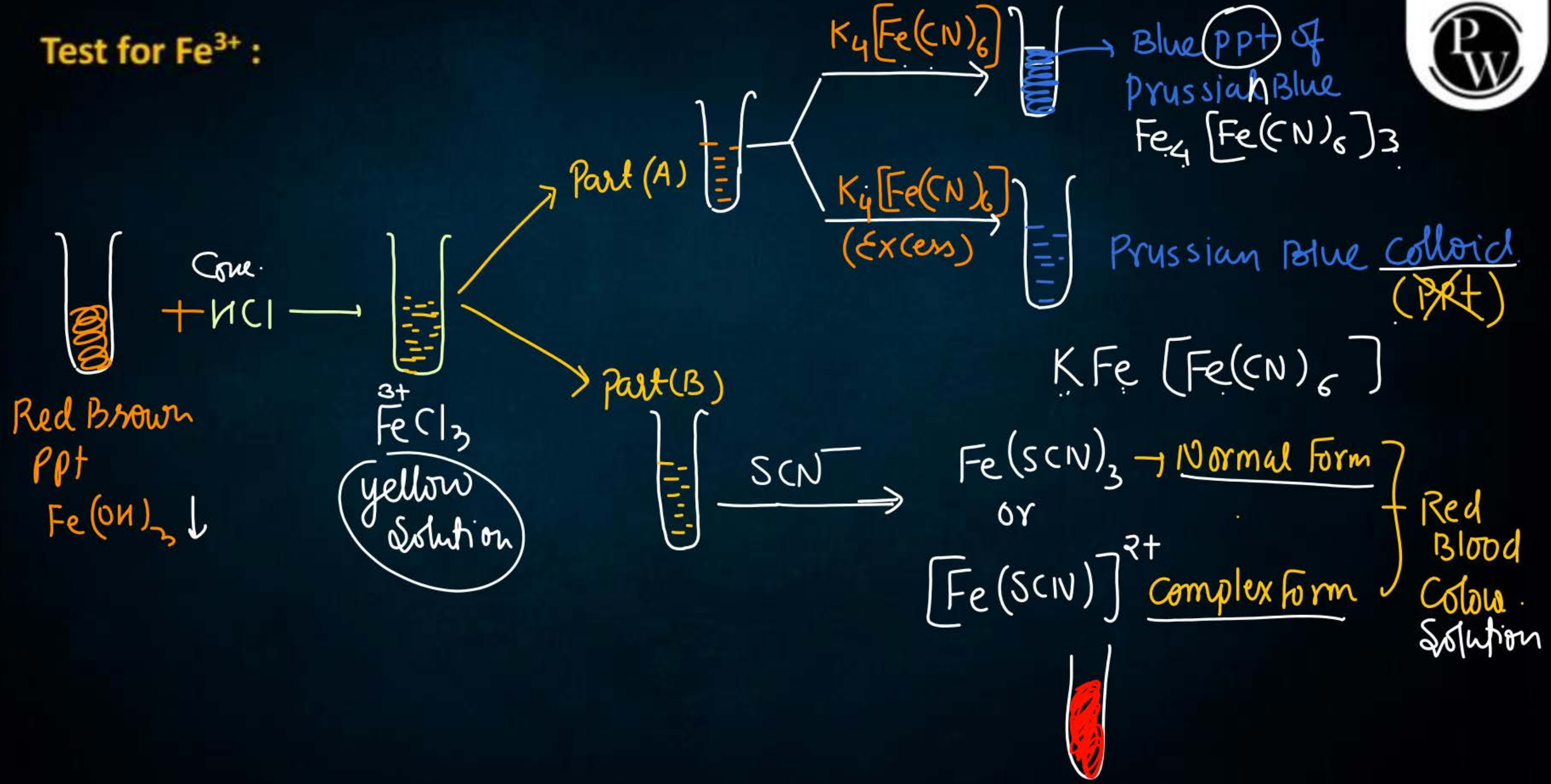
O·S + NH_4OH + NH_4Cl ⟶ (ppt)

- $Al(OH)_3$ white gel. ppt
- $Fe(OH)_3$ → Red Brown ppt
- $Cr(OH)_3$ → green ppt

Test For Al^{3+}

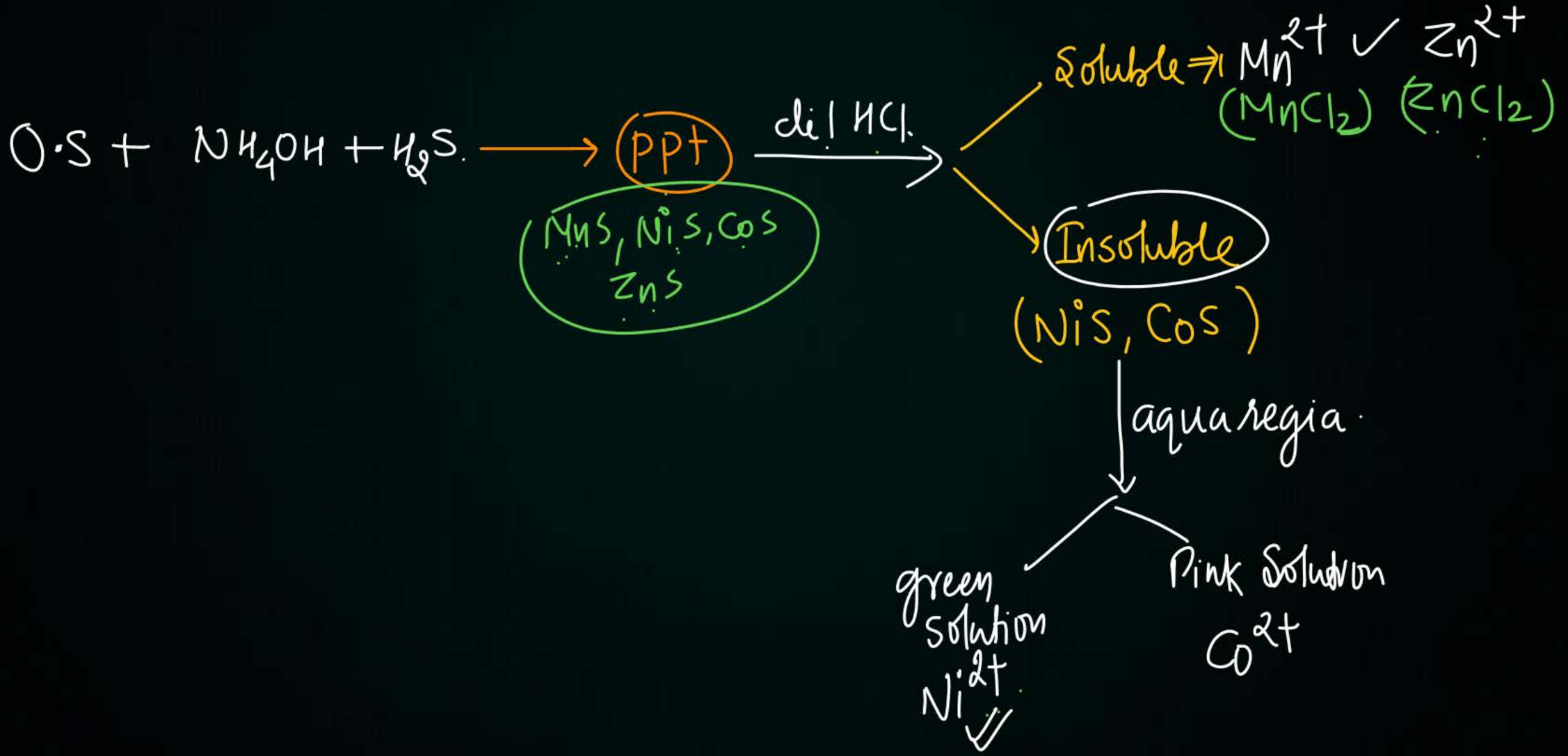

Al(OH)3 ↓
White gel. ppt
C. HCl
AlCl3
Soluble
(Acidic)
Part (A)
NaOH
Excess NaOH
Al(OH)3 ↓
Na[Al(OH)4]
or
NaAlO2
Part (B)
Blue litmus Solution
AlCl3 acidic
(lake test)
dropwise
NH4OH
(Base)
Floating Blue gel ppt
like lake
Al(OH)3 gel. ppt
But Blue due to Basic Medium
Red litmus → Blue
(Basic medium)

Test for Fe^{3+} :


Red Brown ppt
$Fe(OH)_3 \downarrow$
Conc.
+HCl
Fe^{3+}
$FeCl_3$
yellow Solution
Part (A)
$K_4[Fe(CN)_6]$
Blue ppt of Prussian Blue
$Fe_4[Fe(CN)_6]_3$
$K_4[Fe(CN)_6]$ (Excess)
Prussian Blue Colloid (Sol)
Part (B)
SCN^-
$K Fe[Fe(CN)_6]$
$Fe(SCN)_3$ → Normal Form
or
$[Fe(SCN)]^{2+}$ Complex Form
Red Blood Colour Solution

Test For group-IV Cations :- group Reagent :- (H_2S in P.O NH_4OH)

Ni^{2+} Co^{2+} Mn^{2+} Zn^{2+}



Test For Zn^{2+}

White ppt ($ZnS\downarrow$) $\xrightarrow[\Delta]{dil\ HCl}$ Soluble ($ZnCl_2$)

Part (a)

$ZnCl_2$ $\xrightarrow{NaOH}$ $Zn(OH)_2\downarrow$ (gelatinous white ppt)

$Zn(OH)_2\downarrow$ $\xrightarrow{Excess\ of\ NaOH}$ $Na_2[Zn(OH)_4]$ soluble.

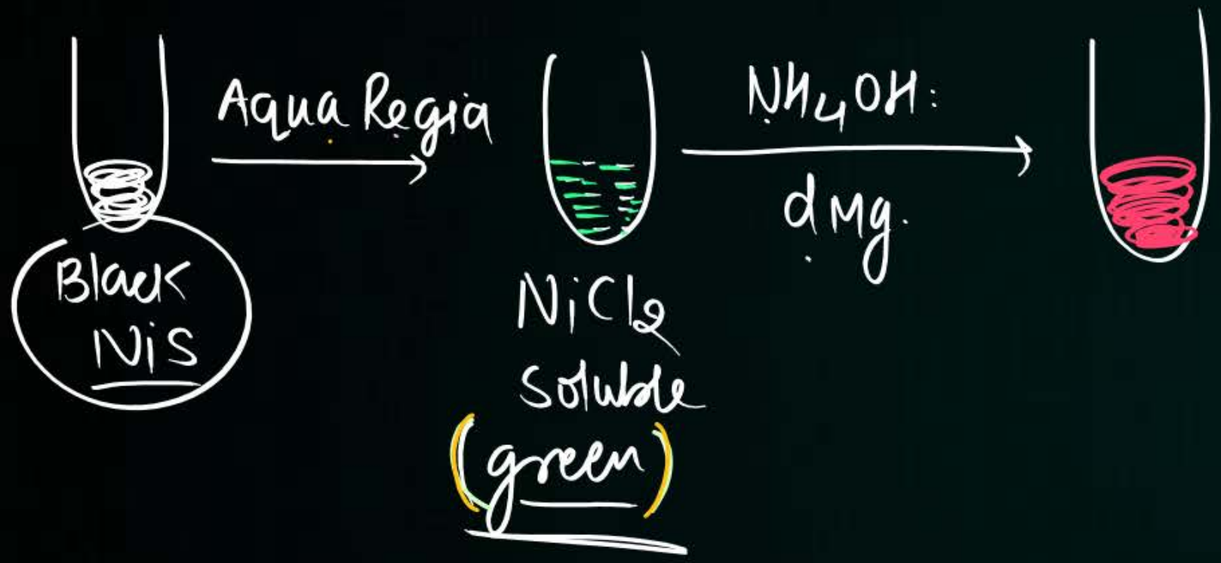
Part (b)

$ZnCl_2$ $\xrightarrow{NH_4OH\ (Base)}$ Neutralization

$ZnCl_2$ $\xrightarrow{K_4[Fe(CN)_6]}$ $Zn_2[Fe(CN)_6]\downarrow$ Blue white ppt

$ZnCl_2$ Acidic

Test For Ni^{2+}



Rosy red/cherry red ppt.

$[Ni(dMg)_2] \downarrow$

dsp^2 Sq. planar

optically Inactive

JEE Mains 2025

Out of Syllabus Question → Confirmatory test of Co^{2+} (Not in syllabus)

CoS + Aqua Regia → $CoCl_2$ Pink solution. $\xrightarrow[KNO_2]{CH_3COOH}$ $K_3[Co(NO_2)_6]$ yellow ppt ↓

Test For group V Cations

Ba^{2+} Sr^{2+} Ca^{2+}

(G·R) $(NH_4)_2CO_3$ in P·O NH_4Cl

O·S + $(NH_4)_2CO_3$ + NH_4Cl ⟶ White ppt $BaCO_3 / SrCO_3 / CaCO_3$

↓

[Preserve Some ppt For Flame test]

Ba → Apple green

Sr → Crimson Red

Ca → Brick Red

White ppt $\xrightarrow{CH_3COOH}$ Soluble

↓

divide into three part a, b, c

$Ba(CH_3COO)_2$

$Sr(CH_3COO)_2$

$Ca(CH_3COO)_2$

(P. chromate)

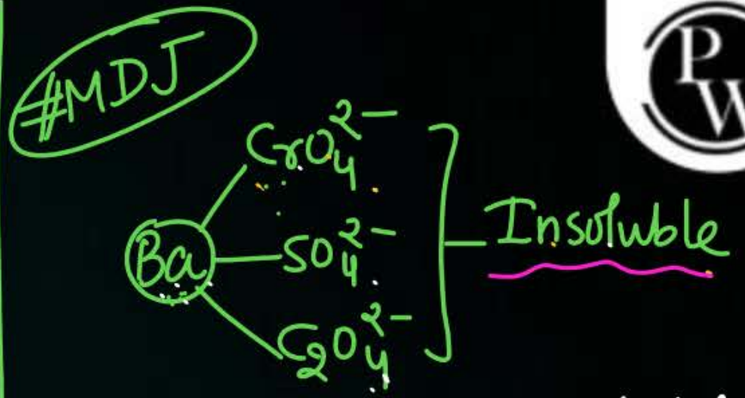
Part (a) $\xrightarrow{K_2CrO_4}$ Yellow ppt of $BaCrO_4\downarrow$ Ba^{2+} Confirmed.

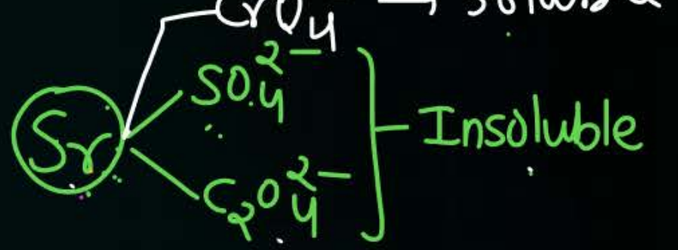
Part (b) $\xrightarrow[(am.\ Sulphate)]{(NH_4)_2SO_4}$ white ppt of $SrSO_4\downarrow$ Sr^{2+} is Confirmed.

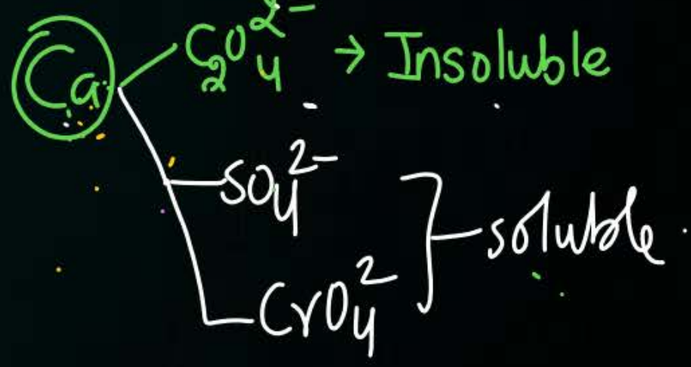
Part (C) $\xrightarrow[(am.\ oxalate.)]{(NH_4)_2C_2O_4}$ white ppt of $CaC_2O_4\downarrow$ Ca^{2+} is Confirmed.

(Calcium oxalate)

#MDJ







group - VII

Na^+, Mg^{2+}*, K^+

test of Mg^{2+}

Filtrate of group (V)

NH_4Cl

$(NH_4)_2CO_3$

Na_2HPO_4 →

$MgNH_4PO_4 \downarrow$ white ppt

Mag. Amm phosphate

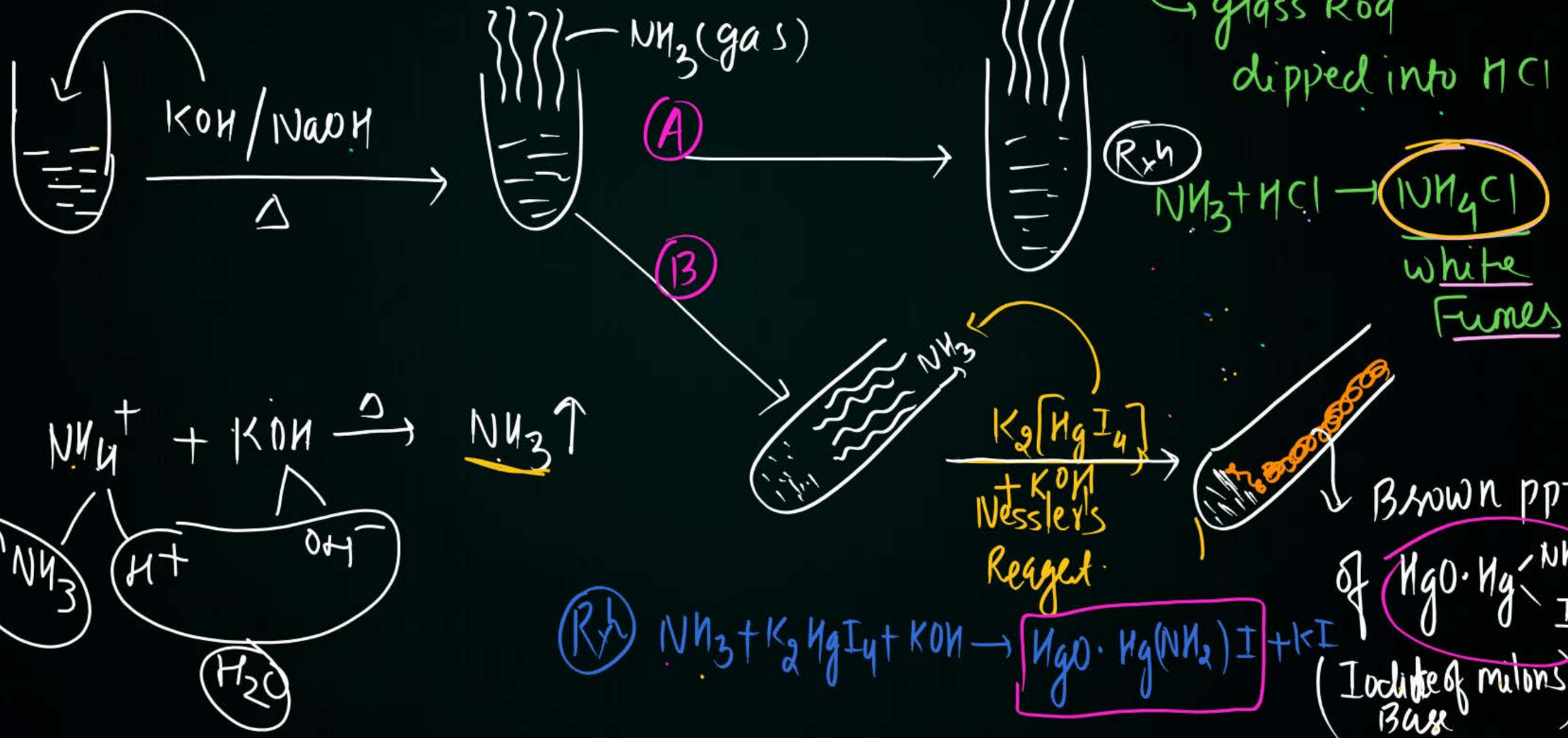
group 0

NH_4^+

→ do not use Previous Filtrate.

→ Always use O.S ✓

Test For Zero group (NH_4^+)



Group-O

NH_4^+ test

Filtrate is not used to test NH_4^+ ion.

Filtrate
Mai Humne
Khud NH_4^+
ions milaye Hai

NH_4OH, NH_4Cl, $(NH_4)_2CO_3$

Always use O.S

O.S NH_4^+ $\xrightarrow{KOH/NaOH}$ NH_3 ↑

$NH_4^+ \rightarrow H^+ + OH^-$

$H_2O + NH_3$

NH_3 + Nessler's Reagent $K_2[HgI_4]$ + KOH

(Red Brown ppt)

($Hg_2O \cdot HgNH_2I$)

($NH_3 + H^+$) → NH_4^+

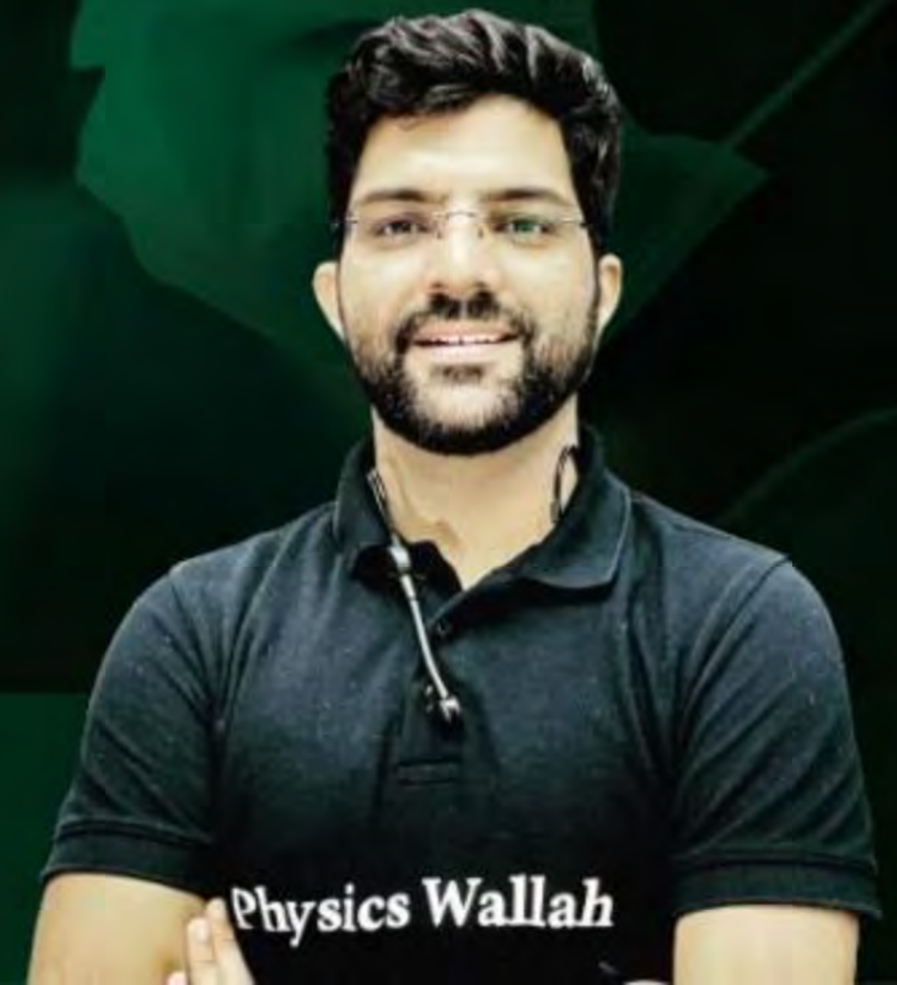
THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture-04 | **Inorganic Chemistry**

Salt Analysis



By - Mohit Dadheech (MD Sir)

Topics *to be covered*

1. Question Practice
2.
3.

QUESTION

An aqueous solution of gas (X) turns red litmus blue; then gas will be

Red $\xrightarrow{\text{Base}}$ Blue

1. SO_2
2. SO_3
3. NH_3
4. None of these

QUESTION

A imparts green colour to the flame. Its solution does not give a precipitate on passing H_2S. When it is heated with solid $K_2Cr_2O_7$ and conc. H_2SO_4, reddish brown gas is evolved. The gas when passed in an aqueous solution of NaOH turns it yellow. Find out A:

1. $HgCl_2$
2. $BaCl_2$
3. Both (A) and (B)
4. None of these

Ba^{2+} apple green colour

$BaCl_2 \xrightarrow{H_2S}$ No ppt

$BaCl_2 + Conc.\ H_2SO + K_2Cr_2O_7 \rightarrow CrO_2Cl_2$ (Red Brown gas)

$CrO_2Cl_2 \xrightarrow{NaOH} Na_2CrO_4$ yellow

Cl^-

QUESTION

Which of the following anions will give same colour of gas?

1. NO_2^-, NO_3^-, $I^{\ominus}$
2. NO_2^-, NO_3^-, CH_3COO^-
3. NO_2^-, $Br^{\ominus}$, $I^{\ominus}$
4. NO_2^-, NO_3^-, $Br^{\ominus}$

QUESTION

White ppt. of silver gives brown ppt. on boiling, but when it is heated (>300°C), then a metallic black ppt. is obtained. Identify the compound of silver having white ppt :

1. Ag_2SO_3
2. $Ag_2S_2O_3$
3. Ag_2CO_3
4. AgCl

$Ag_2CO_3 \xrightarrow{\Delta} Ag_2O \xrightarrow[\Delta]{>300^\circ C} Ag$

Ag_2O: Brown Ppt

Ag: Black Ppt

Metallic Residue

QUESTION

Which of the following compound is formed when CO_2 gas is passed through an aqueous solution of sodium chromate ?

1. $Cr(OH)_3$ is precipitated
2. Yellow solution of $Cr_2(CO_3)_2$ is formed
3. Orange solution of $Na_2Cr_2O_7$ is formed
4. No reaction

$Na_2CrO_4 \xrightarrow[(pH)\downarrow]{CO_2} Na_2Cr_2O_7$

yellow → Orange

QUESTION

The acidic solution of a salt produces blue color with KI starch solution. The salt may be :

1. sulphite
2. bromide
3. nitrite
4. chloride

NO_2^-

$NO_2^- + CH_3COOH + KI + \text{Starch solution}$ → Blue

QUESTION

Violet vapors are given out when ..... is treated with conc. H_2SO_4.

$I^- \longrightarrow I_2 \uparrow$

Violet

1. bromide
2. iodide
3. chloride
4. nitrate

QUESTION

The color developed when sodium sulphide is added to sodium nitroprusside is :

Na_2S

S^{2-} — SNP → Purple

1. purple
2. yellow
3. red
4. black

QUESTION

Which of the following compound does not gives ppt. with dil HCl ?

Group-I G.R

1. $AgNO_3$
2. $Pb(NO_3)_2$
3. $Hg_2(NO_3)_2$
4. $Cu(NO_3)_2$

QUESTION

A gas is obtained by addition of dil. H_2SO_4 to a mixture which turns lead acetate paper black. It is:

1. SO_2
2. CO_2
3. H_2S
4. NO_2

H_2S gas $\xrightarrow{Pb(CH_3COO)_2}$ $PbS\downarrow$ Black

QUESTION

Soda extract is prepared by :

1. fusing soda and mixture and then extracting with water
2. dissolving $NaHCO_3$ and mixture in dil. HCl
3. boiling Na_2CO_3 and mixture, in dil. HCl
4. boiling Na_2CO_3 and mixture, in distilled water

1 : 3

Salt : Na_2CO_3

QUESTION

A white solid is first heated with dilute H_2SO_4 and then with concentrated H_2SO_4. No action is observed in either case. The solid may contians :

1. sulphide

2. sulphite

3. sulphate

4. thiosulphate

Class A anion

Class B

QUESTION

The brown ring test is performed for the qualitative detection of :

1. bromides
2. iodides
3. nitrates
4. phosphates

QUESTION

Which one is not the interfering radical?

1. PO_4^{3-}
2. BO_3^{3-}
3. F^-
4. SO_4^{2-}

QUESTION

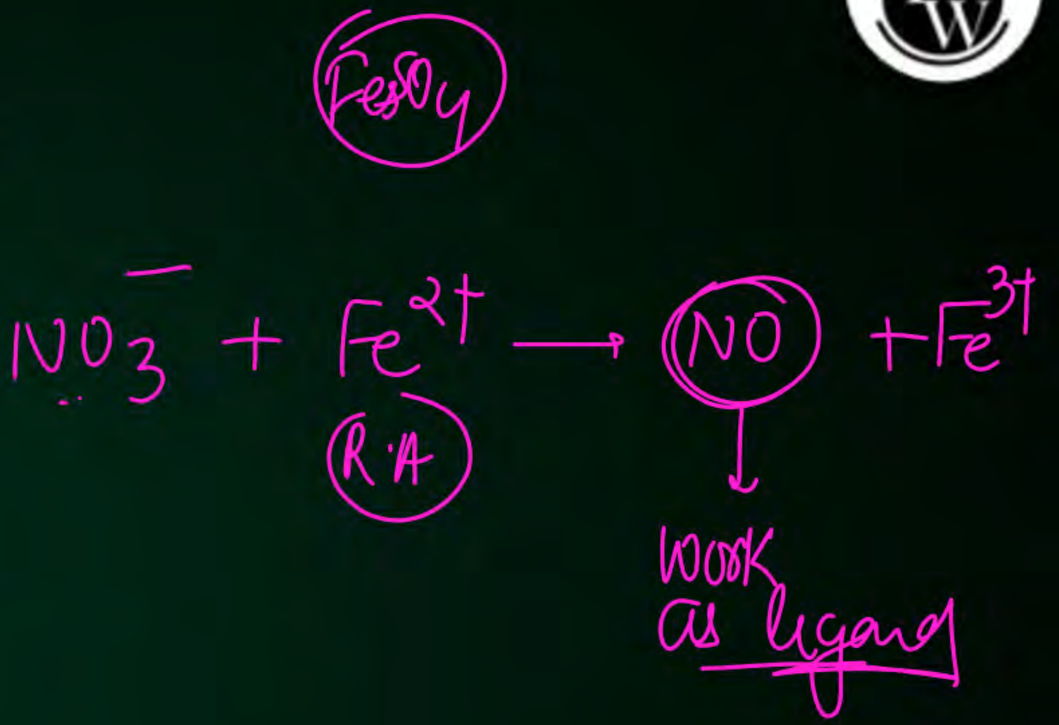
Which of the following sulphides is yellow in colour?

1. CuS Black.
2. CdS yellow
3. ZnS white
4. CoS Black.

QUESTION

The brown ring test for nitrates depends on :

1. the reduction of nitrate to nitric oxide
2. oxidation of nitric oxide to nitrogen dioxide
3. reduction of ferrous sulphate to iron
4. oxidizing action of sulphuric acid



QUESTION

Which one of the following pairs of ions cannot be separated by H_2S in dilute HCl?

1. Bi^{3+}, Sn^{4+} group II
2. Al^{3+}, Hg^{2+}
3. Cu^{2+}, Zn^{2+}
4. Ni^{2+}, Cu^{2+}

H_2S in acidic medium

↓

G.R of group - II

QUESTION

Which of the following metal sulphides has maximum solubility in water?

Solubility

1. HgS, $K_{sp} = 10^{-54}$
2. CdS, $K_{sp} = 10^{-30}$
3. FeS, $K_{sp} = 10^{-20}$
4. ZnS, $K_{sp} = 10^{-22}$

HgS < CdS < ZnS < FeS

K_{sp} ↓ ppt ↑

K_{sp} ↑ → solubility ↑

QUESTION

The compound formed in the borax-bead test of Cu^{2+} ion in oxidizing flame is :

1. Cu
2. $CuBO_2$
3. $Cu(BO_2)_2$
4. None of these

Reducing Flame

$Cu^{+1}BO_2$ Colourless

Cu^{0} → Red

QUESTION

Yellow color solution of $FeCl_3$ changes to light green when :

1. $SnCl_2$ is added (R.A.)
2. Zn is added (R.A)
3. H_2S gas is passed S^{2-} (R.A)
4. All true ✓

Fe^{3+} (yellow) $\xrightarrow{R.A}$ Fe^{2+} (green (light))

QUESTION

Turnbull's blue and Prussian's blue, respectively, are :

I. $Fe^{II}[Fe^{II}(CN)_6]^{2-}$

II. $Fe^{III}[Fe^{III}(CN)_6]$

III. $Fe^{II}[Fe^{III}(CN)_6]^{3-}$

IV. $Fe^{III}[Fe^{II}(CN)_6]^{4-}$

1. I, II
2. I, III
3. III, IV
4. IV, III

QUESTION

The ion most difficult to remove as a precipitate is :

1. Ag^{+}
2. NH_4^{+}
3. Fe^{3+}
4. Cu^{2+}

QUESTION

A colorless gas is dissolved in water and the resulting solution turns red litmus blue; the gas may have been which one of the following ?

1. HCl
2. H_2S
3. SO_2
4. NH_3

QUESTION

What would you observe if you add with shaking, excess dil. NaOH solution to $ZnCl_2$ solution ?

$ZnCl_2 \xrightarrow{NaOH} Zn(OH)_2 \downarrow \xrightarrow{NaOH} Na_2[Zn(OH)_4]$

gel. white ppt

soluble

1. A white ppt.
2. A white ppt. which later dissolves
3. A green ppt.
4. A green ppt. which later dissolves

QUESTION

In the separation of Cu^{2+} and Cd^{2+} in 2nd group of qualitative analysis of cations, tetrammine copper(II) sulphate and tetraammine cadmium(II) sulphate react with KCN to form the corresponding cyanide complexes; which one of the following pairs of the complexes and their relative stabilities enables the separation of Cu^{2+} and Cd^{2+} ?

1. $K_3[Cu(CN)_4]$: less stable and $K_2[Cd(CN)_4]$: more stable
2. $K_3[Cu(CN)_4]$: more stable and $K_2[Cd(CN)_4]$: less stable
3. $K_2[Cu(CN)_4]$: less stable and $K_2[Cd(CN)_4]$: more stable
4. $K_2[Cu(CN)_4]$: more stable and $K_2[Cd(CN)_4]$: less stable

Perfect complex w.r.t H_2S

Stable

$K_3[Cu(CN)_4] \xrightarrow{H_2S}$ No Reaction.

$K_2[Cd(CN)_4] \xrightarrow{H_2S} CdS\downarrow$ yellow ppt

Imperfect complex w.r.t H_2S

QUESTION

Prussian blue is formed when :

1. Ferrous sulphate reacts with $FeCl_3$
2. Ferric sulphate reacts with $K_4[Fe(CN)_6]$
3. Ferrous ammonium sulphate reacts with $FeCl_3$
4. Ammonium sulphate reacts wit h$FeCl_3$

QUESTION

Ca, Ba, and Sr ions are precipitated in fifth group as their :

1. Oxides
2. Sulphates
3. Carbonates
4. Sulphides

G.R $(NH_4)_2CO_3$ in P.O NH_4Cl

QUESTION

Conc. H_2SO_4 and addition to dry KNO_3 gives brown fumes of :

1. SO_2
2. SO_3
3. NO
4. NO_2

$NO_3^- + C.H_2SO_4 \longrightarrow NO_2\uparrow$

QUESTION

group - IV

H_2S gas, on passing through an alkaline solution, forms a white precipitate. The solution contains ions of

1. Pb ✗
2. Zn ✓
3. Cu ✗
4. Ni

NiS } Black
CoS }

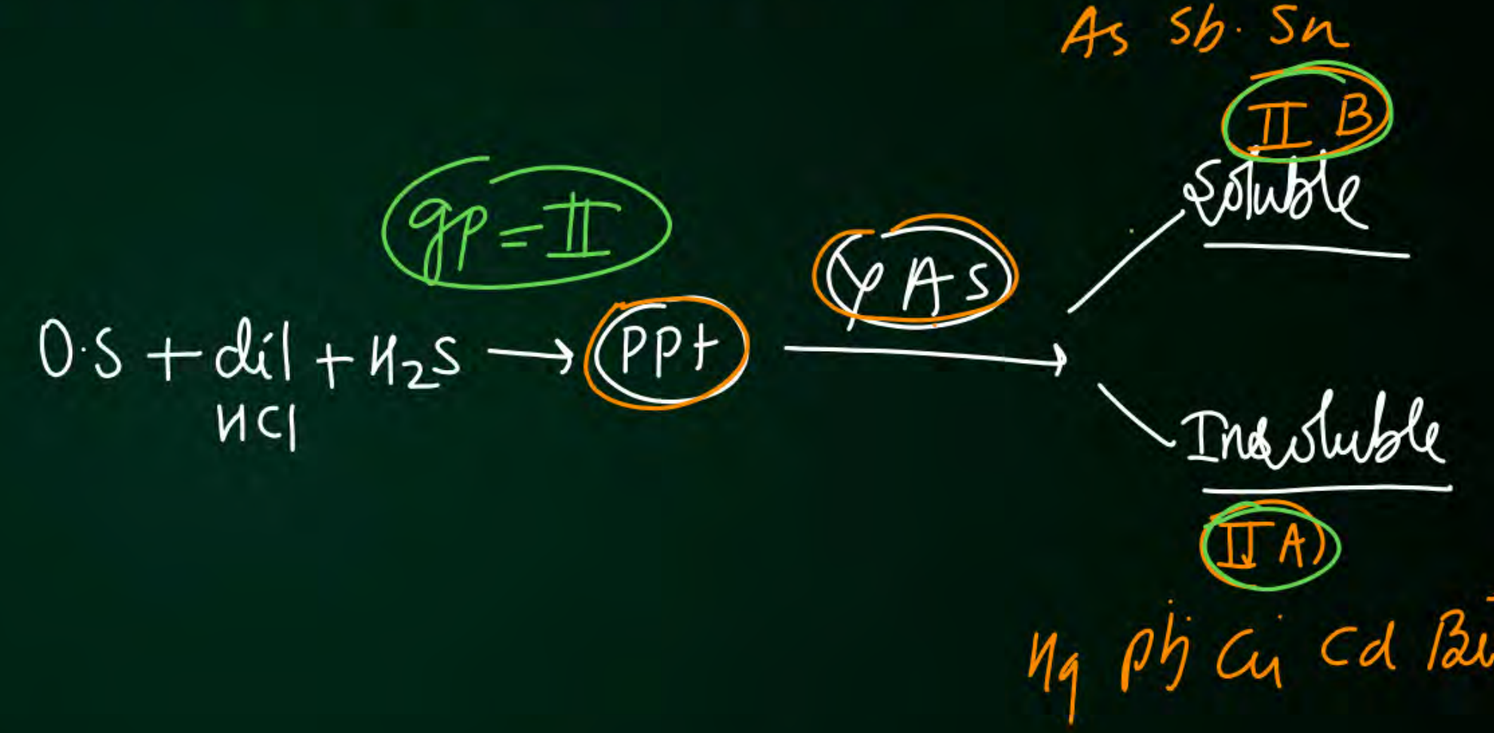
ZnS → white

MnS → light pink

QUESTION

Yellow ammonium sulphide solution is a suitable reagent used for the separation of :

1. HgS and PbS ✗
2. PbS and Bi_2S_3 ✗
3. Bi_2S_3 and CuS ✗
4. CdS and As_2S_3 ✓



QUESTION

The presence of NH_4^+ radical in solution can be detected by :

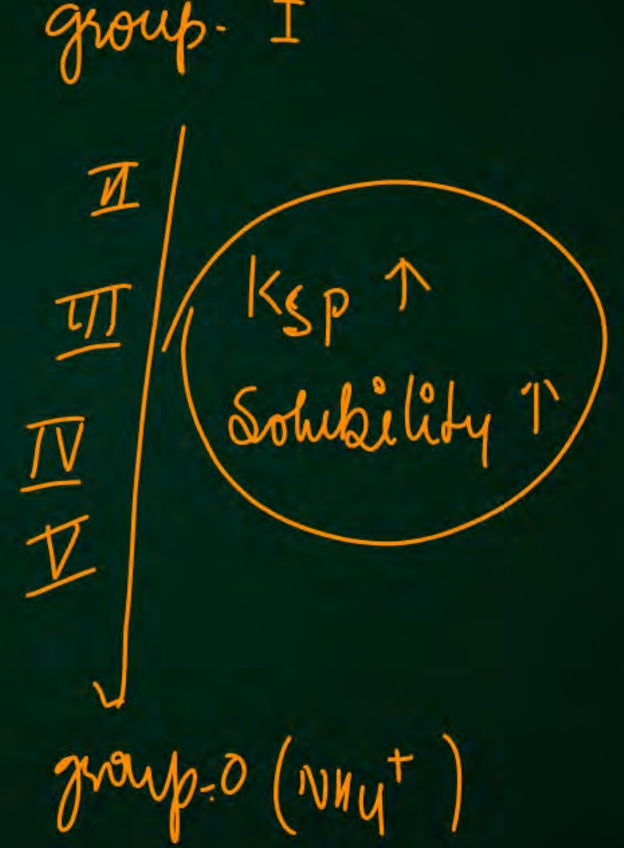
1. Fehling's solution
2. Benedict's solution
3. Schiff's reagent
4. Nessler's reagent ✓

$(K_2[HgI_4] + KOH)$

QUESTION

Which of the following sulphides has the maximum solubility product?

1. HgS II
2. PbS IV
3. CuS II
4. MnS IV



QUESTION

A black sulphide is formed by the action of H_2S on :

1. $CuCl_2$ (CuS) Black
2. $CdCl_2$ CdS Yellow
3. $ZnCl_2$ .. ZnS White
4. NaCl X

QUESTION

$Pb(CH_3COO)_2$ gives ..... Colour with H_2S :

1. Black
2. White
3. Red
4. Oragne

QUESTION

Acidified $K_2Cr_2O_7$ turns green by :

1. CO_2 (+4) ✗
2. SO_3 (+6) ✗
3. SO_2 (+4) ✓
4. HNO_3 (+5) ✗

$Cr^{+6} \xrightarrow{R.A} Cr^{3+}$ (green)

$S^{+4} \longrightarrow S^{+6}$ (R.A)

QUESTION

The II group precipitates soluble in yellow ammonium sulphide may be :

1. As, Sb, Sn (IIB)
2. Cu, Hg, Bi, Cd (IIA)
3. Both (A) and (B)
4. None of these

QUESTION

$C.HNO_3 \rightarrow$ O.A

Conc. Nitric acid is generally not used for preparation of original solution in analysis of basic radicals, because it:

1. Is oxidizing agent
2. Is reducing agent
3. Forms insoluble nitrates
4. Forms soluble nitrates

Cold H_2O
Not H_2O
dil Cl
Conc Cl
dil HNO_3
aqua Reg.
Conc HNO_3

QUESTION

When dimethyl glyoxime solution is added to an aqueous solution of nickel chloride in presence of ammonium hydroxide :

1. A black ppt. is formed
2. A blue ppt. is formed
3. A rose red ppt. is formed
4. No ppt. is formed

$NiCl_2$ (Ni : 27) $\xrightarrow[NH_4OH]{dmg}$ Rosy Red PPT

$Ni(dmg)_2$

QUESTION

An inorganic salt solution on treatment with HCl will give a white precipitate of which metal ions:

group – I

1. Hg_2^{2+}
2. Hg^{2+}
3. Zn^{2+}
4. Al^{3+}

QUESTION

Which of the following anions are easily removed from aqueous solution by precipitation?

1. Cl^-
2. SO_4^{2-}
3. NO_3^-
4. CO_3^{2-}

QUESTION

Which of the following cation is not present in III group?

1. Al^{3+}
2. Fe^{3+}
3. Cr^{3+}
4. Cu^{2+}

QUESTION

When H_2S gas is passed in a metal sulphate solution in presence of NH_4OH, a white precipitate is produced. The metal is/are identified as :

1. Zn
2. Fe
3. Pb
4. Hg

H_2S in Basic Medium

gp-IV

QUESTION

The Incorrect statement is, with respect to chromyl chloride test :

1. Formation of lead chromate $PbCrO_4$
2. Formation of chromyl chloride CrO_2Cl_2
3. Liberation of chlorine gas ~~Cl_2~~
4. Formation of reddish-brown vapors

QUESTION

Match the column :

	Column I		Column II
(A)	Fe^{2+} react with $K_3[Fe(CN)_6]$	(p)	Cherry red ppt.
(B)	Fe^{3+} react with $K_4[Fe(CN)_6]$	(q)	Turn bull's blue
(C)	Ni^{2+} react with DMG	(r)	Prussian blue
(D)	Cu^{2+} react with NH_3 solution	(s)	Blue solution

$[Cu(NH_3)_4]SO_4$

QUESTION

Match the column :

	Column I		Column II
(A)	Ag^{+}	(p)	zero group radical
(B)	Pb^{2+}	(q)	I group radical
(C)	Fe^{3+}	(r)	II group radical
(D)	NH_4^{+}	(s)	III group radical
		(t)	IV group radical

A → q , B → q, r . C → s , D → p

QUESTION

Match the column :

	Column I (Radical)		Column II (Group reagent)
(A)	Ag^+ gp I	(p)	dil HCl
(B)	Al^{3+} gp - III	(q)	H_2S gas in acidic medium
(C)	Zn^{2+} gp - IV	(r)	NH_4OH in presence of NH_4Cl
(D)	Cu^{2+} gp - II	(s)	H_2S gas in basic medium
		(t)	$(NH_4)_2 CO_3$

A → p B → r C → s D - q

QUESTION

Match the column :

	Column I		Column II
(A)	Pb^{2+}	(p)	1st group
(B)	Cu^{2+}	(q)	zero group
(C)	NH_4^+	(r)	3rd group
(D)	Al^{3+}	(s)	2nd group

A → p,s B → s C → q , D → r

QUESTION

Match the column :

	Column I		Column II
(A)	Chromyl chloride test	(p)	H_2S
(B)	Rotten egg smell	(q)	SO_2
(C)	Suffocating smell	(r)	$K_4[Fe(CN)_6]$
(D)	Brown chocolate test of Cu^{2+}	(s)	CrO_2Cl_2
		(t)	$K_2Cr_2O_7$

SOq

A → s,t, B → p, C → q, D → r

QUESTION

Oxidation number of iron is NOT change on :

1. Reaction of mohr's salt + $KMnO_4/H^+$ solution

2. Reaction of sodium sulphide with sodium nitroprusside solution

3. Reaction of HNO_3 with green vitriol solution

4. Reaction of ferric alum with H_2S in acidic solution

QUESTION

Which of the following des not give gaseous product on treatment with concentrated HNO_3 ?

1. $BaCO_3$
2. $NaNO_2$
3. $Ca_3(PO_4)_2$ (Class-12) SO_4^{2-}, PO_4^{3-}
4. $CaBr_2$

QUESTION

If addition of a concentrated mineral acid is made to an unknown salt, a colourless and odoruless gas is produced, then which of the following can be present ?

1. CO_3^{2-} $CO_2 \uparrow$
2. S^{2-} H_2S
3. Cl^- HCl white.
4. NO_3^- NO_2.

QUESTION

Samples of which test tube when mixed gives white precipitate ?

1. $BaCl_2 + AgNO_3 \rightarrow AgCl\downarrow$
2. $BaCl_2 + ZnSO_4 \rightarrow BaSO_4\downarrow$
3. $ZnSO_4 + NaOH \rightarrow Zn(OH)_2\downarrow$

} white ppt

4. All of these ✓

QUESTION

Cation which is not precipitated by H_2S neither in acidic medium not in basic medium is :

1. Pb^{2+}
2. Zn^{2+}
3. Ag^{+}
4. Ba^{2+}

QUESTION

Anion which produces white ppt. with $BaCl_2$ which is soluble in dil. HCl is :

1. NO_3^-
2. CO_3^{2-}
3. SO_4^{2-}
4. S^{2-}

$BaCO_3$ white ↓ $\xrightarrow{HCl}$

$BaSO_4$ white ↓ $\xrightarrow{HCl}$ Insoluble

$\xrightarrow{HNO_3}$ Insoluble

QUESTION

IV^{th} group cations are not precipitated by dil. HCl + H_2S because :

1. K_{sp} of the sulphide of IV^{th} group cations are low.
2. K_{sp} of the sulphide of IV^{th} group cations are high.
3. K_{sp} of the sulphide of II^{th} group cations are high.
4. Sulphide of IV^{th} group cations are water soluble.

QUESTION

Which of the following cations is not precipitated by $NH_4Cl + NH_4OH$?

1. Al^{3+}
2. Cr^{3+}
3. Fe^{2+}
4. Fe^{3+}

QUESTION

A test tube contains solution of $Pb(NO_3)_2$, $AgNO_3$, $Zn(NO_3)_2$. Which of the following will be precipitated by Na_2S ?

1. PbS
2. ZnS
3. Ag_2S
4. All of these

QUESTION

Ions which do not produce volatile product with conc. H_2SO_4, are :

1. Na_2CO_3
2. $BaSO_3$
3. $ZnSO_4$
4. NH_4Br

QUESTION

Fe^{3+} ions produces deep blue colouration when treated with reagent (R). R is :

1. $K_3[Fe(CN)_6]$
2. $K_4[Fe(CN)_6]$
3. KSCN
4. Excess of NH_4OH

QUESTION

Select compound which is written with its colour correctly.

1. K_2MnO_4 (Purple)
2. CdS (Black)
3. Cr_2O_3 (Green)
4. MnS (Black)

QUESTION

Blue colouration is not produced when :

1. $Cr_2O_7^{2-} + H_2O_2 \xrightarrow{H^+}$ CrO_5

2. $Fe^{3+} + KSCN \rightarrow$ $Fe(SCN)_3$ Red Blood

3. $K_4[Fe(CN)_6] + Fe_2(SO_4)_3 \rightarrow$ P.B Colour

4. $NO_2 + NO \xrightarrow[\text{Cooling}]{-30°C}$ N_2O_3 Blue

QUESTION

Which of the following ions is not identified by $AgNO_3$ solution ?

1. F^- ⟶ AgF ppt solution

2. Cl^- $\xrightarrow{AgNO_3}$ AgCl ↓ white

3. Br^- ⟶ AgBr ↓ Pale yellow

4. I^- ⟶ AgI yellow ppt.

QUESTION

Which of the following has scarlet red ppt. ?

1. $HgCl_2$
2. Hg_2Cl_2
3. Cu_2I_2
4. HgI_2

QUESTION

Sulphur dioxide may be recognized by its :

1. Characteristic pungent smell of burning sulphur.
2. Ability to turn dichromate paper green.
3. Ability to decolourize acidified $KMnO_4$ solution.
4. All of the above.

$Cr^{3+} \xrightarrow{SO_2} Cr^{3+}$ green

$Mn^{+7} \xrightarrow{SO_2} Mn^{2+}$ Colourless

QUESTION

or CCl_4

When CS_2 layer containing both Br_2 and I_2 is shaken with excess of Cl_2 water, the violet colour due to I_2 disappears and orange colour due to Br_2 appears. The disappearance of violet colour is due to the formation of :

1. I_3^-
2. HIO_3
3. ICl_3
4. I^-

Colour

$Br^-/I^- \xrightarrow{Cl_2} Br_2/I_2$

$\downarrow$ Excess Cl_2

Colourless

QUESTION

Statement-1 : Coloured cations can be identified by borax bead test.
Statement-2 : Transparent bead ($NaBO_2 + B_2O_3$) forms coloured bead with coloured cation.

I & II ✓

Explanation ✓

QUESTION

Which of the following gelatinous ppt dissolve into excess of NaOH

1. $Al(OH)_3$

$Al(OH)_3 \xrightarrow[\text{Excess}]{NaOH} \underset{\text{soluble}}{Na[Al(OH)_4]}$

2. $Mg(OH)_2$ ✗

3. $Fe(OH)_3$ ✗

4. All of these

QUESTION

Which one is coloured ppt ?

1. $Mg(OH)_2$
2. $CaCO_3$
3. $ZnCO_3$
4. $Cr(OH)_3$

white.

green

QUESTION

AgCl ppt is soluble in excess of NH_3 due to

1. Acid base reaction
2. due to formation of OH^- of Ag
3. Complex formation reaction
4. Redox reaction

$[Ag(NH_3)_2]^+$

QUESTION

Chromyl Chloride test can be given by

(A) $MnCl_2$ (B) NaCl (C) AgCl (D) $BaCl_2$

1. A & B
2. A, B & D
3. B, C
4. A, B & D

QUESTION

White ppt, completely soluble in $NH_3(aq)$, is

or

NH_4OH

1. $AgNO_3$ ✗
2. AgCl ✓ Complete
3. $HgCl_2$ ✗
4. AgBr partial

QUESTION

Flame test is not given by

1. $MgCl_2$
2. LiCl
3. KCl
4. $CaCl_2$

N.W

QUESTION

Microcosmic salt is

1. $(NH_4)_3PO_4$
2. $NaNH_4HPO_4.4H_2O$
3. $Na_2B_4O_7.10H_2O$
4. $NH_4NaHO_3.7H_2O$

Phosphate Bead test

$NaNH_4HPO_4 \xrightarrow{\Delta} NaPO_3 + NH_3\uparrow + H_2O\uparrow$

$NaPO_3$ → Bead

$NaPO_3$ → Sod. Metaphosphate

Bead + salt → Coloured Bead

Colours same as Borax Bead test

QUESTION

Thenard Blue is

1. $CoO.ZnO$
2. $CoO.Al_2O_3$
3. $CoO.MgO$
4. $CuSO_4.5H_2O$

Zn · green
Al · Blue
Mg · Pink

QUESTION

Colour of Borax bead test of Fe in oxidising flame is

1. Red

H.W

2. Yellow

3. Green

4. White

QUESTION

Transition Metals

Borax Bead test is not possible for

1. Ni
2. Cu
3. Fe
4. Zn

QUESTION

In which test, brilliant red Color is formed

1. Colour of Lake in lake test of Al^{3+}
2. Colour of Prussian Blue in test of Fe^{3+}
3. Colour of $[Ni(dmg)_2]$ in test of Ni^{2+}
4. Colour of $Mg(NH_4)PO_4$ in test of Mg^{2+}

QUESTION

True statement about solution containing Fe^{3+}

1. Can be reduced by $SnCl_2$
2. Gives ppt with NaOH → $Fe(OH)_3$ ↓ Red Brown ppt
3. Give blue ppt with $K_4[Fe(CN)_6]$
4. All

QUESTION

$$\text{A(white ppt)} \xrightarrow{\text{dil. HCl}} \text{Soluble (B)} \xrightarrow{\text{NaOH}} \text{white ppt} \xrightarrow{\text{exc. NaOH}} \text{soluble (D)}$$

1. $Fe(OH)_3$
2. $Cu(OH)_2$
3. ZnS White ppt
4. $CaCl_2$

$ZnS \xrightarrow[HCl]{dil} ZnCl_2$ Soluble

(A) (B)

$ZnCl_2 \xrightarrow{NaOH} Zn(OH)_2 \downarrow \xrightarrow[Excess]{NaOH} Na_2[Zn(OH)_4]$ Soluble

(C) (D)

QUESTION

Which is correctly matched

	PPT	Colour
1	$PbCrO_4$	Red
2	$Fe_4[Fe(CN)_6]_3$	Green
3	$Ni(dmg)_2$	Blue
4	$Zn_2[Fe(CN)_6]$	Blue white

H.W

QUESTION

Aq. solution of cation X $\xrightarrow[\text{dil. HCl}]{H_2S}$ Black ppt in borax test for salt of X.

oxidizing flame → Blue

Reducing flame → Red

Then X is.

1. Pb^{2+}
2. Co^{2+}
3. Zn^{2+}
4. Cu^{2+}

QUESTION

The green colour produced in the borax bead test of a chromium(III) salt is due to

[JEE(Main) 2019]

1. CrB
2. Cr_2O_3
3. $Cr(BO_2)_3$
4. $Cr_2(B_4O_7)_3$

QUESTION

Which of the following statement(s) is /are correct. When a mixture of NaCl and $K_2Cr_2O_7$ is gently warmed with conc. H_2SO_4? [JEE 1998]

1. A deep red vapours is evolved. ✓

H.W

2. The vapours when passed into NaOH solution gives a yellow solution of Na_2CrO_4 ✓

3. Chlorine gas is evolved ✗

4. Chromyl chloride is formed.

QUESTION

An aqueous solution of a substance gives a white precipitate on treatment with dilute hydrochloric acid, which dissolves on heating. When hydrogen sulphide is passed through the hot acidic solution, a black precipitate is obtained. The substance is a : [JEE 2000]

1. Hg_2^{2+} salt
2. Cr^{2+} salt
3. Ag^+ salt
4. Pb^{2+} salt

O.S + dil HCl ⟶ ppt —Boiling→ Soluble (Pb^{2+}, $PbCl_2$)

Insoluble: Ag^+ Hg_2^{2+}

PbS ↓ ← H_2S

QUESTION

$[X] + H_2SO_4 \rightarrow [Y]$ a colourless gas with irritating smell [JEE 2003]

$[Y] + K_2Cr_2O_7 + H_2SO_4 \rightarrow$ green solution

[X] and [Y] are :

1. SO_3^{2-}, SO_2

2. Cl^-, HCl

3. S^{2-}, H_2S

4. CO_3^{2-}, CO_2

SO_2

$K_2Cr_2O_7 \xrightarrow{CO_2} X$

$K_2Cr_2O_7 \xrightarrow{SO_2} Cr^{3+}$ green.

QUESTION

Passing H_2S gas into a mixture of Mn^{2+}, Ni^{2+}, Cu^{2+} and Hg^{2+} ions in an acidified aqueous solution precipitates [JEE 2011]

1. CuS and HgS
2. MnS and CuS
3. MnS and NiS
4. NiS and HgS

QUESTION

Upon treatment with ammonical H_2S, the metal ion that precipitates as a sulfide is - [JEE 2013]

H_2S in Basic Medium.

H.W

1. Fe (III)
2. Al (III)
3. Mg (II)
4. Zn (II)

QUESTION

The colour developed, when sodium sulphide is added to sodium nitroprusside is :

1. Purple
2. yellow
3. red
4. black

H.W

QUESTION

In layer test of I^- and Br^-. If reddish -brown layer comes first then -

1. Br^- present
2. I^- absent
3. Both (1) and (2)
4. None of these

QUESTION

Always Use 0.5

Statement-1 : Test of NH_4^+ can not be done within group analysis
Statement-2 : During group analysis several times NH_4^+ - compound is added at the different steps.

1. Statement-1 is true, statement-2 is true and statement-2 is correct explanation for statement-1
2. Statement-1 is true, statement-2 is true and statement-2 is NOT the correct explanation for statement-1
3. Statement-1 is false, statement-2 is true.
4. Statement-1 is true, statement-2 is false.

QUESTION

Cu^{2+} + KCN (in excess) → soluble complex (X). How many statements are correct regarding complex (X) –

(i) the central atom has the co-ordination number of 6 ✗

(ii) the central atom has the co-ordination number of 4 ✓

(iii) the complex is sq.planar ✗

(iv) the complex is diamagnetic ✓

(v) the complex is paramagnetic ✗

$Cu^{2+} \xrightarrow[\text{Excess}]{KCN} K_3[Cu(CN)_4]$

O.S. ⇒ Cu^{+1} d^{10}

dia

tetra

(ii), (iv) ✓

QUESTION

What is the group-III reagent is generally used for group analysis.

1. $NH_4OH + NH_4NO_3$

2. $NH_4Cl + (NH_4)_2CO_3$

3. $NH_4OH + (NH_4)_2SO_4$

4. $NH_4OH + NH_4Cl$

H.W

QUESTION

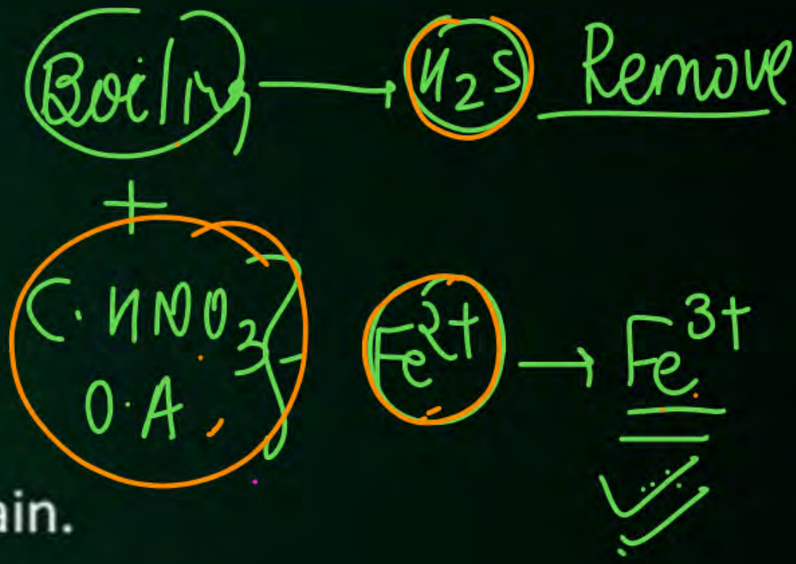
Which of the following cation gives ppt in two groups during group analysis

1. Hg^{2+}
2. Hg_2^{2+}
3. Pb^{2+}
4. Cu^{2+}

QUESTION

What are the following steps are to be done before adding group-III reagent into the group-II filtrate.

1. Group-II filtrate is to be evapourated to dryness
2. Group-II filtrate is to be boiled of first
3. After boiling 2-3 drops of dil.H_2SO_4 is added and boiled again.
4. After boiling 2-3 drops of HNO_3 is added and boiled again.



QUESTION

Nitrate is confirmed by ring test. The brown colour of the ring is due to formation of

1. ferrous nitrite
2. nitroso ferrous sulphate
3. ferrous nitrate
4. $FeSO_4NO_2$

QUESTION

When I_2 is passed through KCl, KF, KBr :

1. Cl_2 and Br_2 are evolved
2. Cl_2 is evolved
3. Cl_2, F_2 and Br_2 are evolved
4. None of these

QUESTION

On passing a gas, 'X', through Nessler's regent, a brown precipitate is obtained. The gas 'X' is [JEE Mains 2024]

1. Cl_2
2. NH_3
3. CO_2
4. H_2S

QUESTION

Statement (I): The gas liberated on warming a salt with dil H_2SO_4, turns a piece of paper dipped in lead acetate into black, it is a confirmatory test for sulphide ion.

Statement (II): In statement-I the colour of paper turns black because of formation of lead sulphite.

In the light of the above statements, choose the most appropriate answer from the options given below:

[JEE Mains 2024]

1. Both Statement I and Statement II are false
2. Statement I is true but Statement II is false
3. Statement I is false but Statement II is true
4. Both Statement I and Statement II are true

QUESTION

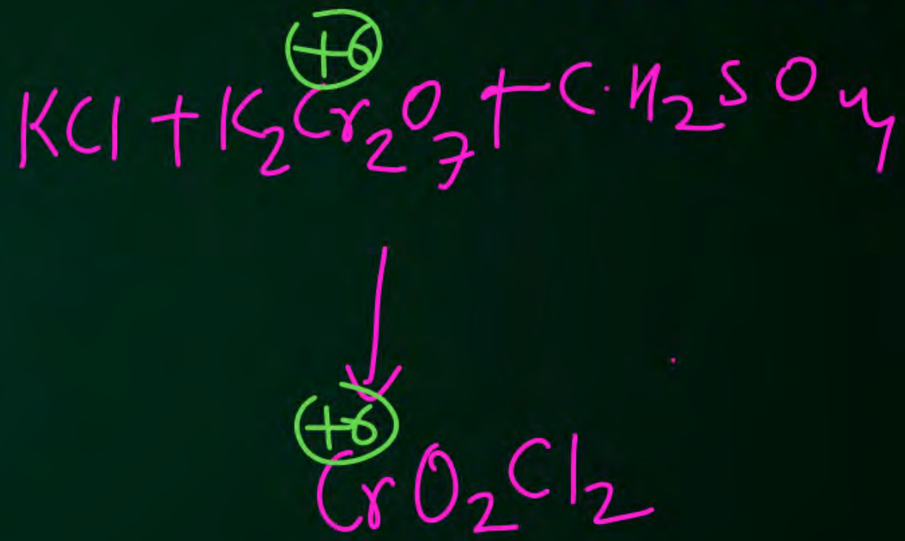
The compound that is white in color is [JEE Mains-2024]

1. ammonium sulphide (yellow)
2. lead sulphate $PbSO_4 \downarrow$ white
3. lead iodide PbI_2 yellow
4. ammonium arsinomolybdate yellow

QUESTION

In the reaction of potassium dichromate, potassium chloride and sulfuric acid (conc.), the oxidation state of the chromium in the product is (+) _____.

[JEE Mains-2024]



QUESTION

Given below are two statements :
Statement (I) : Dimethyl glyoxime forms a six-membered covalent chelate when treated with $NiCl_2$ solution in presence of NH_4OH.
Statement (II) : Prussian blue precipitate contains iron both in (+2) and (+3) oxidation states. In the light of the above statements, choose the most appropriate answer from the options given below : **[JEE Mains-2024]**

1. Both Statement I and Statement II are true
2. Both Statement I and Statement II are false
3. Statement I is false but Statement II is true
4. Statement I is true but Statement II is false

QUESTION

NaCl reacts with conc. H_2SO_4 and $K_2Cr_2O_7$ to give reddish fumes (B), which react with NaOH to give yellow solution (C). (B) and (C) respectively are :

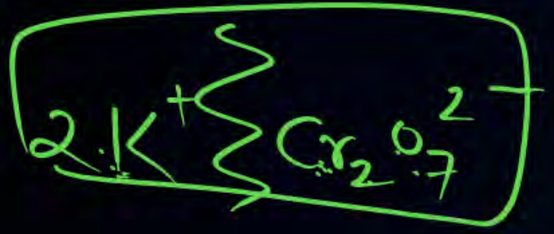
[JEE Mains-2024]

1. CrO_2Cl_2, Na_2CrO_4
2. CrO_2Cl_2, $KHSO_4$
3. Na_2CrO_4, CrO_2Cl_2
4. CrO_2Cl_2,$Na_2Cr_2O_7$

iii) Why Solid $K_2Cr_2O_7$ is Used :— In Chromyl chloride test

(Ans) If we use $K_2Cr_2O_7$ in form of solution.
there will be more no. of Cr^{+6} ions available.
which are strong oxidising in nature &
hence oxide Cl^- into Cl_2 (Redox Rxn occurs)

Solid



"Humko Rxn Non Redox Hi Rakhni Hai"

In Chromyl Chloride test.

i) Why CH_3COOH is used?

Ans → to Neutralise Excess amount of NaOH.

otherwise in next step Pb will be

Soluble into NaOH & form $[Pb(OH)_4]^{2-}$

NOTE Avoid excess amount of Cl_2 water because it further oxidise I_2^0 into IO_3^- (+5)

and avoid shaking also

(Same For Br_2 also)

$$Cl_2 + H_2O + I^- \longrightarrow \underset{\text{(colourless)}}{HIO_3}$$

(excess)

NOTE If Br^- & I^- Both are present in Salt then Violet layer Comes first Followed by Red Brown layer.

* If Red Brown layer Comes first Means I^- is absent.

Bada Sawal

Why H_2S gas is used in acidic medium as a reagent for group-II cation ? (H_2S + dil HCl)

Ans

$$H_2S \longrightarrow H^+ + S^{2-}$$

(H_2S dissociation ↓se in acidic medium)

Because when H_2S gas ionize then S^{2-} Conc^n is sufficient for ppt^n of II as well as IV group cations.

But in acidic medium S^{2-} conc. ↓se due to Common ion effect

$$HCl \rightleftharpoons H^+ \; Cl^-$$

$$H_2S \rightleftharpoons 2H^+ \; S^{2-}$$

Bada Sawal

Why H_2S gas is Used in Basic medium For Group IV Cations

$(NH_4OH + H_2S)$

$H_2S \longrightarrow 2H^+ + S^{2-}$

$NH_4OH \longrightarrow NH_4^+ + OH^-$

odd ion effect Reaction Forward

Because More S^{2-} Conc. is req. For Ppt of group IV

Bada Sawal

Why NH_4Cl is added with NH_4OH for III group → Ppt in form of OH^-

(Ans) to prevent dissociation of NH_4OH By Common ion effect.

If OH^- Conc. is High then ppt of $Mg(OH)_2$ May Come

$NH_4OH \rightleftharpoons NH_4^+ + OH^-$

$NH_4Cl \rightleftharpoons NH_4^+ + Cl^-$

(Al^{3+} Fe^{3+} Cr^{3+}) (OH^-)

Hurry up!

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#VishwasDiwasWithPW

THANK YOU